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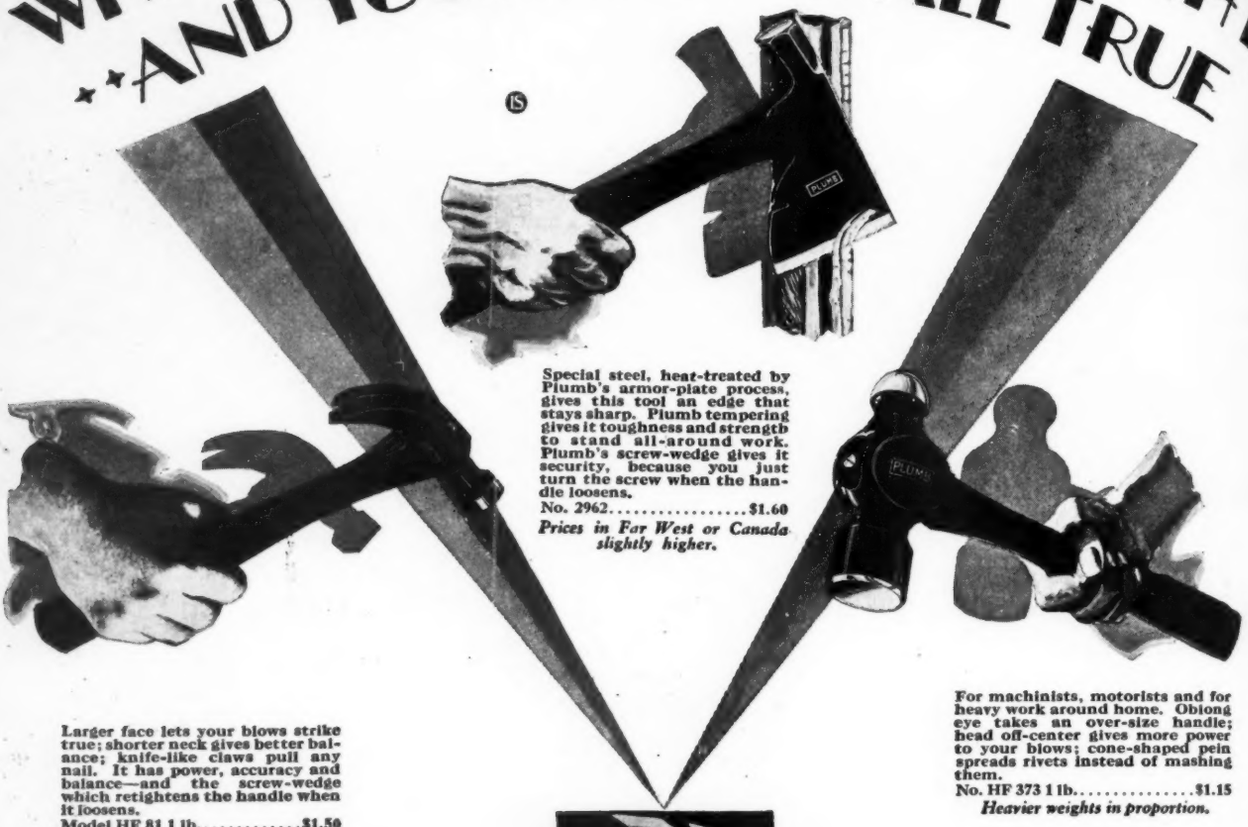

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WHAT IS NEW THIS MONTH

Table of Contents for May

LEADING ARTICLES

DICK BYRD—ADVENTURER . . . . . *By Fitzhugh Green* 13
The romantic story of one of America's greatest airmen

WHIZZING AT A HUNDRED YARDS A SECOND! . . . *By Carl Helm* 16
A 207-mile-an-hour dash that shattered a world's record

NEW WIZARDRY OF COMPRESSED AIR . . *By Robert E. Martin* 19
How leashed whirlwinds serve you in daily life

TO DELIVER MUSIC BY WIRE . . . . . *By Edwin Ketchum* 21
Radio programs over your electric light lines in latest amazing plan

RISKING DEATH FOR SCIENCE . . . . . *By Earl Chapin May* 25
Why daring inv stigators experiment on themselves

A SHIP THAT CAN FIGHT A SQUADRON . . . . *By Herbert Paus* 27
An artist's impression of the airplane carrier *Saratoga*

YOUNG AMERICA FINDS ITS WINGS . . . *By Edgar C. Wheeler* 28
Creating a new race of aviation engineers

VILE SMELLS MADE INTO PERFUMES . . *By P. A. Carmichael* 30
The amazing origin of scents that charm

THE WIND'S WHIRLIGIG OF DEATH . . . . . *By L. G. Pope* 31
Our newest knowledge of the havoc-spreading tornado

NEW WORLD AIR TRAILS BLAZED . . . . . *By Hyatt E. Gibson* 33
The thrilling story of two epochal air jaunts

GIVES 42 QUARTS OF BLOOD TO SAVE 86 LIVES
. . . . . *By George Lee Dowd, Jr.* 34
Cheating death with modern marvel of transfusion

WHEN ICEBOXES BREED GERMS . . . *By Frederic Damrau, M.D.* 35
Dangers of an inefficient refrigerator

PUZZLERS MEET IN WAR OF WITS . . . *By Alden P. Armagnac* 38
Behind the scenes with the makers of brain-teasers

PITFALLS THAT AWAIT INVENTORS . . . . *By Bruce Donald* 39
What to do with your patent

ATTIC INVENTOR'S MAGIC EYE SEES ACROSS THE OCEAN
. . . . . *By H. C. Davis* 41
How a penniless pioneer achieved television

SECRETS OF ANIMAL TALK REVEALED . . *By Warren MacDougall* 45

CARS OUR READERS CHOOSE . . . . . *By Martin Bunn* 46
Helpful pointers for prospective buyers in Popular Science auto contest

SOLVING THE MYSTERY OF THE SHAPE OF THE EARTH
. . . . . *By Edna Kenton* 50
If our planet is not a globe, then what?

A WHOLE FARM IN YOUR YARD . . . . . *By E. Bade* 56
How to plan your summer garden

HE BUILT A HOME IN ODD TIME . . . *By John R. McMahon* 69
An amateur-built dwelling that was finished in six months

AVIATION SLANG . . . . . *By Brock Mays* 72
Interesting gleanings from the airman's parlance

OUR READERS SAY 10

FICTION

THE ELECTRIC PILOT . . . . *By Beryl D. and Orville H. Kneen* 22
A breath-taking episode in the life of a stunt-flyer

THE MOVIE MAKER—PART FOUR . . . . *By S. W. Newmeyer* 42
Secrets of the film world in a thrilling novel

RADIO

MAKING YOUR RADIO SPEAK UP . . . . *By Alfred P. Lane* 66

AMAZING NEW AMPLIFYING TUBE . . . . . *By John Carr* 68

THE HOME WORKSHOP

PAINTING WITH HAND SPRAYERS . . . . . *By Berton Elliot* 77

OUR *Mayflower* TAKES SHAPE . . . *By E. Armitage McCann* 78

MAKING THE MOST OF A LATHE . . . . *By Albert M. Thomas* 84

Automobiles

New Auto Engine to Save Gas . . 48
Motor Car That Can Swim Devised to Explore Alaska 49
Know Your Car 62
Interchangeable Truck Motor . . 62
Mirror Keeps Traffic Lights in View . 74
A Locked Tool Compartment . . 74
Handy Spouted Can 74
Light Shows Brake Position . . . 74
Ten Dollars for an Idea! 74

Astronomy

Largest American-Made Telescope Mirror Cast 48
Solving Secret of Glow in Sky . . 53
Boy Builds Own Telescope . . . 55

Aviation

Flight in Aged Plane Shows Aero Progress 18
Railroad Yards to be Airports Too . 37
Planes and Gas Fight Locusts . . 52
He Flies 18,000 Miles a Month . . 54
Planes Sink Ship in Test . . . 58
Now You Can Insure Home Against Wreckage by Airplanes . . . 59
Flyer Loops Loop 1,111 Times . . 59
Speaking Tubes for Aviators . . 60
Did Balloon Clock Cost Life? . . 62

Engineering

S-4 Salvage Project Uses Model Pontoon 18
Artificial Sea for Sahara 48
High Bridge Engineering Feat . . 58

Exceptional People

Three Science Medals Won . . . 49
Makes Tricks for Stage Musicians . 57
Designing Insignia Is Sergeant's Unique Job 57

Exploration

Prehistoric Animal Bones Unearthed in South America 49
South Sea Expedition. 59

Health and Hygiene

Gains in War on Disease. 49
Hair Grows by Spurts 53

Laboratory Discoveries

Ultra-Violet Glass on Trial . . . 48
New Power of X-Rays Found . . 52
Unique Nonmagnetic Ship Seeks More Secrets of Sea 53
Radio Tube Used Backwards Aids Study of High Voltage. 62

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Models

Tiny Earth, Sun and Moon Keeping Pace with Real Ones 54
Yachts of Paper 57
Mayflower Ship Model 78
Airplane Model for Racing 82
Models Made from Our Blueprints . 108

New Devices for the Home

Nonclogging Salt Shaker . . . 64
Turn of Wrist Adds Salt and Pepper . 64
"Iceless" Ice Balls Chill Drinks . . 64
Ironing Board Hammock . . . 64
Guards Your Milk Bottle . . . 64
Makes Coffee under Pressure . . 64
Flat-Lid Teakettle of Many Uses . 64
Floor Scraper Broom Attachment . 64
Odd Fork Mixes Food 65
Deep-Dish Pie Cup 65
Speedy New Toaster 65
Latest Cooker Lies Flat, Stands on End 65
"One-Way Window" Tells You Who Is Outside 65
Novel Suction Hanger 65
Lazy Tong Window Washer . . . 65
New Oven Scoop 65

New Processes and Inventions

The Mechanical Man Shown by His Maker 18
Device Reveals Voice's Struggles with Foreign Languages . . . 49
Compact New Seismograph Records Earthquakes 49
Telephoning through the Sea . . 52
Automatic Typewriter Cover . . 52
Flowerpot Stand Aids Plants . . 52
Blackboard Drawing Device . . 52
Mechanical Tennis Opponent . . 53
Golf Tee and Pencil in One . . . 53
Microscope in Pen Barrel . . . 53
New Clock Run and Regulated from Wall Socket 54
Coal Oil Distilled by New Process . 55
Machine Buries Power Wires . . 59
New Edison Miners' Lamp . . . 60
Wheelbarrow with Caterpillar Tread Will Not Cut Ground 60
New Hat Rack Saves Space . . . 60
Bag Keeps Golf Clubs from Cutting Green 60
Vise Attachment Holds Tubes Firm . 60
Typewriter Shifts Carriages . . . 61
Device to Stop Gas Poisoning . . 61
Tides Operate Electric Buoy . . 61
Bank Vault Oxygen Tank . . . 61
Umbrella Pocket in Bag 61
Target Records Your Score . . . 61
Rigid Hack Saw Saves Blades . . 61
Building Bricks Made of Waste from Big Baking Powder Plant . . . 63
Lumber Dried by Electricity . . 63
Machine Takes Phone Call, Repeats It on Your Return 63

Photography

As Many Photos As You Wish . . 59
Camera Built into Hand Bag . . 60

Radio

Trans-Atlantic Radio Joins Two Conventions 18
Radio Tone Made Still Purer . . 49
Radio Patents Flood Britain . . 55
Wave Length Used in Unison by Two Big Radio Stations 58

Unusual Facts and Ideas

Pontoons of 60-Hour Atlantic Speedboat 18
Relics 3,000 Years Old Dug Up Near Berlin 18
Ants Have Fire Department . . . 48
Sunken Island Is Grumbling . . . 49
Millions of Pounds of Air Blown Every Day in Organs 52
Hibernation Next to Death . . . 52
Air Fans Quiet Din in Tunnel . . 52
Highways to Link Americas . . . 53
What Do You Want to Know? . . 53
Millions of Gallons of Gas Saved by Light Tank Paint 54
Ship Fights Storm with Syrup . . 54
Electric Alarms for Sleepy Students . 55
Nothing at All—a Vacuum—Worth Millions to the World 55
Tiniest Plant Makes 12 World's Best Accordions a Year 57
Stout Hickory Rods and 24-Thread Lines Catch Swordfish 57
1,309,918 Bulbs in Signs 58
Four Centuries of Bicycle History . 58
Weather on Air Six Times a Day . 59
Pupils Make Musical Instruments . 59
"Synthetic Grain" Proposed . . . 59
Clock Set in Floor of Bank . . . 61
Hard Slate Cut Like Cheese by Cable Filled with Sand 62
Air Tubes Carry Red-Hot Steel . . 62
Unbreakable Concrete Poles . . . 63
New Products of Corn Waste . . 63
How Much Do You Know of the World You Live In? 63

For the Home Owner

Double-Duty Screen Door 88
Hints on Puttying and Painting . . 98
Repairing Wall Fabrics 98
Filling Floor Cracks 98
How to Repair Chipped Fixtures . 100
Magnetic Tack Hammer . . . 100

Hints for the Mechanic

Taper Boring Attachment for a Lathe 86
Hack Saw Pad 86
Holder for "Sizing" Packing Rings . 86
Seat for Use on Derrick 86
V-type Straps Used as Lathe Dog . 86
Shop-Made Milling Attachment . 104
Jig for Drilling Oil Holes . . . 104

Ideas for the Handy Man

Two Cabinets that Hold All a Boy's Treasures 79
A Movable Saw Table Wheeled on Casters 80
Wood Turning for Beginners . . 81
Refinishing a Canvas Canoe . . 90
Novel Pipe Rack Has Japanese Lines 95
How to Make Sticking Drawers Run Smoothly 95
How to Make White Library Paste 97
Blueprints for Your Home Workshop 101
Home Workshop Chemistry . . . 103
Anvil Makes a Novel Paper Weight 104
A Useful Trick for Pressing Men's Ties 108
A Simple Way to Prepare Colored Marbled Paper 110
Improving a Paint Sprayer . . . 112
Driftwood Novelties of Cypress . . 118

Keeping Abreast of the Times

Interesting questions you now will be able to answer

1. What single ship can defy a whole battle fleet? (p. 27)
2. In what great city is "wired radio" to have its first tryout on a large scale? (p. 21)
3. Why did Costes and Lebrix, round-the-world French flyers, really undertake their amazing trip? (p. 33)
4. What poor young inventor made biscuit tins and soap boxes into a home television set? (p. 41)
5. What bird can "talk" with an alphabet of twenty-four letters? (p. 45)
6. Who piloted a record-shattering racing auto built on airplane lines? (p. 16)
7. What prominent official advocates roofing railroad tracks for airports? (p. 37)
8. Why must certain dangerous medical experiments be tried on human beings instead of animals? (p. 25)
9. What is the national group whose members call one another by such odd, fanciful names as "Skylight" and "Zoroaster"? (p. 38)
10. How fast is a tornado believed to whirl? (p. 32)
11. Why were experts overjoyed when they broke open the mold containing the largest telescope mirror ever cast in America? (p. 48)
12. What important precautions should you take in selling a patent? (p. 39)
13. What is the latest method of performing a blood transfusion? (p. 34)
14. What is meant, in aviation slang, by a "kiwi" a "washout"? (p. 72)
15. What famous aviator and explorer was a football star in his youth? (p. 15)
16. Do experts now believe that the earth is really a sphere? (p. 50)
17. How can you make one flower garden yield two crops of blooms? (p. 56)
18. What insects have fire departments? (p. 48)
19. What is the correct way to spray a table with lacquer? (p. 77)
20. How does a new electric clock bring you observatory time? (p. 54)

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The Modern Mortgage ... minus the melodrama

By WALLACE AMES, *Financial Editor*

"SO YE spurn my attentions, Prudence Potter! Well, me proud beauty, I'll learn ye that Josiah Prindle is not a man to be trifled with. To-morrow at twelve, if the money is not in my office the foreclosure sign goes on your front door step. I'll see you and your widowed mother out on the street. Maybe that'll bring ye to yer senses."

That was supposed to be the mortgage in the old, colorful melodrama days, the mortgage that gave the hero his chance to thwart the plans of flint-hearted old Money Bags and bring about the happy ending.

The "10–20–30" dramatization of the mortgage lender was more entertaining than it was true to life. In the days when "burning tears" stained the cheeks of "me proud beauty" the real estate mortgage was one of the most popular and most highly respected forms of investment. Not only did savings banks and insurance companies invest their funds in mortgages, but lawyers, administrators of estates and individuals with surplus funds in every city, village and hamlet, seldom thought of any kind of investment but the mortgage.

Investors in local communities knew little about stocks and bonds. In those days Wall Street was to them but another type of melodramatic villain. But they did understand the mortgage; they put their money into security they could see and which they knew to be safe. Perhaps the widespread popularity of the mortgage as a form of investment was responsible for its frequent distortions by the blood-and-thunder playwright.

THERE is even a greater difference in benefits, to both investor and property owner, between the modern methods of mortgage banking and old-fashioned mortgage lending than there was between the former and the melodrama picture. In the old days the process of negotiating a mortgage was very simple and informal. The borrower was asked how much he wanted to borrow. If it was not more than half to two-thirds of the appraised value of the property, papers were drawn, notes signed and the transaction closed. The investor collected his interest direct from the borrower (and often because of friendship submitted to delays). As it was customary to renew matured mortgages the borrower rarely made provision to pay off the loan when it fell due.

An interesting contrast to the old-fashioned informality are the modern methods and the battery of safeguards employed in mortgage banking to-day. Modern mortgage banking has taken the time-honored real estate mortgage, retained all its virtues and added several refinements so that within the past twenty years or so literally a new form of investment has been created and one that has proved eminently satisfactory to hosts of individuals in the investment of their hundreds of millions of dollars.

The place of the local practitioner who "drew up the papers" has been taken by the departmentalized mortgage institution with its corps of highly trained experts and specialists. Even before it reaches the point of passing on an individual mortage loan application, the modern banking institution is constantly studying and surveying general building conditions and trends. Thus the loan value of a specific piece of property is based not alone on its actual worth, but on its value as affected by the trend of the times.

THE most complete example of the methods employed in modern mortgage banking occurs in the case of a piece of new construction. In the beginning the fact is established that there is a need, a demand for the proposed type of building in the neighborhood where it is to be situated. If the locality is already over-built or if that type of building is incongruous with its surroundings the loan is denied.

If the project in general seems feasible the bankers' architectural and engineering departments go over the plans for the new structure. Are sufficient elevators provided? Are they located so as to make the least inroads on rentable, income-producing space? Are modern conveniences and efficiency units provided? (Incidentally, the mortgage banker's architectural department is often the testing laboratory for such devices as electric refrigerators, oil burners, incinerators, ventilating systems and the like.) Is the plan generally practical, flexible and best adapted to the class of tenants that such a building should attract? Is the foundation deep enough? Structurally will the building be fireproof and otherwise safe? These questions but suggest the searching character of the investigation to which a proposed loan is subjected. Often changes and improvements in plans and specifications are made at the suggestion (or the demand) of the mortgage banker.

Aside from the normal legal routine, such as investigation of title, the owner of the property is thoroughly investigated. His financial standing is checked up. All plans for financing secondary to the first mortgage are investigated and studied to assure that the project is thoroughly sound financially as well as structurally. Management experience is also scrutinized to protect against the possible failure of a worthy project through inefficient control. *(Continued on page 6)*

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The Modern Mortgage

(*Continued from page 4*)

After every conceivable line of investigation has been pursued and the mortgage loan finally made, every step of the actual construction of the building is checked and supervised by the banker's construction department. This department sees that original specifications are adhered to, that no hidden short cuts or false economies are indulged in. After the building is completed the banker's supervision continues during the life of the mortgage. He sees to it that the building is properly protected by insurance, that taxes are paid when due, that no mechanics' leins or other incumbrances are allowed to become a claim prior to the first mortgage. The earnings statements of the building are checked periodically.

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Behind the Scenes Where Bonds Are Made tells how you can retire in fifteen years and have an income equal to your present living budget. This booklet can be secured by writing to Cochran and McCluer Company, 46 North Dearborn Street, Chicago, Ill.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

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The Modern Mortgage

(*Continued from page 5*)

income is collected by the owner, he remits to the banker one-twelfth of the total amount required to meet that year's interest and principal payment. Instead of the full amount of the mortgage running for a period of years, without any payments on principal being made in the meantime, the borrower agrees to pay off a part of the loan each year, so that at the final expiration of the mortgage it has been substantially reduced in amount. The effect of this annual repayment is an increase in the security since the entire property remains mortgaged after part of the loan has been paid.

IN THE case of the old-fashioned mortgage with its periodic renewals the property often ceased to be worth as much as the amount of the mortgage before the latter was paid. The rate of repayment of the modern mortgage is faster than the degree of deterioration of the property.

Instead of issuing one mortgage for the full amount of the loan and then finding an investor with just that amount of money to invest, the banker issues mortgage bonds in convenient amounts, $100, $500 and $1,000, so that any individual can invest whatever amount he has and so that he can divide his money over several mortages rather than placing it all in one. Thus the investor of limited means can still invest in a mortgage on a big building. He is not limited to the small home mortage.

In modern mortgage banking the unsatisfactory element of personal contact between borrower and investor is eliminated. The possibility of impositions, delays, favors and deals that may be good friendship but poor business are avoided. The banker negotiates with the borrower on a strictly business basis. All collections are made by the banker and the investor receives his interest simply by depositing his bond coupons in his bank or presenting them direct to the mortgage banking firm.

IT WAS true in the melodrama mortgage days and is true to-day that improved real estate is the soundest and most fundamental form of security. Modern mortgage banking has greatly increased the convenience of this form of investing as well as improved upon its safety by such protective measures as only a highly specialized institution can provide.

THIS Financial Department is to help readers in the establishment of financial programs; it is to assist those who have accumulated money in the proper investment of it so that it will be safe and so that it will grow. The editor of this Department is an authority on investment matters and he not only gives readers every month useful investment information in his articles but he is also ready to give aid in individual investment problems. Address your inquiries to Wallace Ames, Financial Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York.

Majestic Hotel and RESTAURANTS

PEERLESS cuisine and superb music—smart gowns and brilliant people—unique location and luxurious appointments—blend to make that indefinable "lure of the Majestic." Experienced travellers know and appreciate its rare individuality—they always return.

Send for free booklet and information on new World Travel Bureau

Copeland Townsend
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2 West 72nd Street New York
Entire block fronting Central Park

Write for this Free Book!

on 6% GUARANTEED UNITED FIRST MORTGAGE BONDS

Guaranteed United First Mortgage Bonds offer all of the advantages of first mortgages without the difficulties of finding them in convenient amounts, of searching titles, or of collecting interest payments and otherwise supervising the investment.

Payment of both interest and principal is guaranteed by the United States Mortgage Bond Company, a $20,000,000 institution operating under the supervision of the State of Michigan.

Partial payments if desired. Write today for our free investment book, "Plant An Acorn". Use the coupon.

UNITED STATES MORTGAGE BOND COMPANY
Howard C. Wade, *President*
365 U. S. Mortgage Building, Detroit, Mich.
Resources more than $20,000,000
In Canada: United Bond Co., Ltd., Toronto and Windsor, Ont.

MAIL THIS COUPON TODAY

UNITED STATES MORTGAGE BOND CO.
365 U. S. Mortgage Bldg., Detroit, Mich.
Please mail copy of your booklet, "Plant an Acorn".
*Name*_____
*Address*_____
*City*_____ *State*_____

Your favorite gasoline + ETHYL = Elimination of "knock" More Power Quicker Pick-up Less Shifting Cooler Engine

LEADING oil companies throughout the United States and Canada are offering gasoline in two forms.

The first is straight motor gasoline. The second is motor gasoline to which has been added "Ethyl" fluid. This superior fuel is called Ethyl Gasoline.

"Ethyl" fluid, containing tetraethyl lead, controls the combustion rate of gasoline, thereby eliminating "knock" and giving added power for tough hills and heavy roads, greater flexibility, quicker pick-up and all round better performance. As for high compression engines—they were made possible through Ethyl Gasoline!

Drive to a pump which bears the "Ethyl" emblem, shown at the right. The price of Ethyl Gasoline will be merely the price of good motor gasoline, plus the few extra pennies the "Ethyl" ingredient costs. The small premium is insignificant when compared with the added performance.

ETHYL GASOLINE CORPORATION

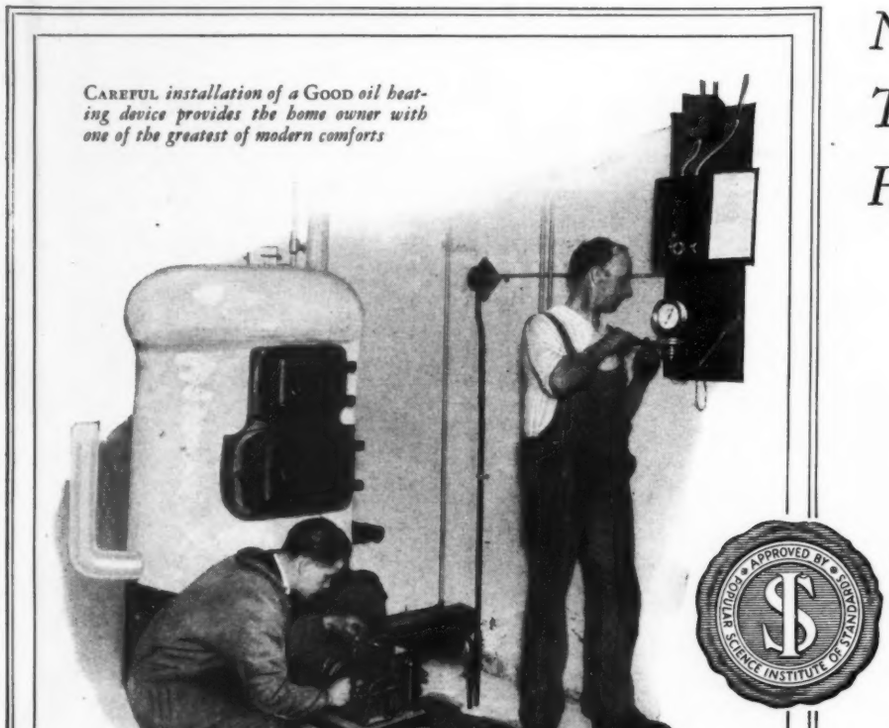
25 Broadway, New York City · 56 Church St., Toronto, Ont., Can.

ETHYL GASOLINE

Ethyl Gasoline is the "anti-knock" (high compression) fuel by which other gasolines are measured.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

BETTER HOME HEATING



CAREFUL *installation of a* GOOD *oil heating device provides the home owner with one of the greatest of modern comforts*

Now Is the Time To Plan Next Year's Heating Improvements

BY
COLLINS P. BLISS, M.A.
Director
Popular Science Institute of Standards

THERE is no season of the year when the idea of a new heating arrangement has more appeal to the average home owner than at the end of a long winter of shoveling—and sometimes shivering. Now, with the time fast approaching when next year's supply of fuel must be put in, is a good season to look into better heating methods.

Heating with oil is a comparatively new and modern method that has found favor with hundreds of thousands of home owners within the past few years who have been wise enough to invest in *good* oil heating equipment. Then, there is a small group who look on oil heating with anything but favor; they put in an inefficient oil heater.

Talking with people who belong to this latter group naturally makes a man dubious as to the wisdom of installing this type of heat. The trouble is that his knowledge of oil heating is based on the unfortunate experience of the minority, which always gets the attention. The natural fears arising are ones that need not be considered at all in the purchase of a reliable oil heating device.

The matter of fire hazard is the one subject that seems to come up most frequently in any discussion of oil heating. The best answer to objections to oil heating on this ground is that there is no increase in insurance rates when an oil heater approved by the Underwriters' Laboratories is installed according to specifications. As a matter of fact, fires resulting from such installations are less frequent than chimney and other fires occurring when coal is used as fuel. The fires that one hears about are almost invariably ones that occurred in connection with oil heating installations that do not come within the above mentioned class; the oil heaters listed by the Underwriters' Laboratories represent only a small percentage of the various makes sold.

The matter of efficiency, or degree of satisfaction an oil heating device will give, in so far as general operating characteristics are concerned, is one that the Underwriters' Laboratories do not attempt to determine in their testing work. In fact, this is something that tests cannot definitely reveal. When it was decided that the Popular Science Institute of Standards would extend the scope of its reader service to include oil heating, it was determined that the only way to get accurate and dependable information on this type of equipment was to question owners. Therefore, investigators were sent into 1,500 homes from New York to California where oil heating equipment was installed and the owners questioned on all essential points in regard to operation, such as amount of servicing required, quality of service rendered, cost of operation, etc. Another 2,000 users were questioned by mail.

The findings from this survey indicated very definitely that efficient oil heating equipment was available and that owners the country over looked upon it as the greatest home convenience that had come to them in the last twenty years.

Readers who wish recommendations of oil heating devices found to be reliable have the Institute's free service at their disposal. In writing, state (a) number of rooms, (b) type of heating system, (c) annual coal consumption, (d) electricity or gas installed. Address the Popular Science Institute of Standards, 250 Fourth Avenue, New York, N. Y.

Popular Science Monthly
GUARANTEE

The above seal on an advertisement indicates that the products referred to have been approved after test by the Popular Science Institute of Standards.

POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use. Our readers in buying these products are guaranteed this satisfaction by POPULAR SCIENCE MONTHLY. THE PUBLISHERS

Uses for this *grainless* wood are steadily increasing from New York to Hollywood!

Possesses uniform strength and remarkable workability. Highly resistive to moisture. Very tough and dense. Has a smooth, attractive surface on the face side, and requires no paint for protection. Also takes any finish beautifully. Send for large, free sample.

TWO years ago, after a long series of tests and experiments, a modern inventive genius succeeded in producing a wood better, in several ways, than Nature's own material. It was much denser, far tougher, had greater moisture resistance. And it was *grainless!*

This product, known as Masonite Presdwood, has already shown almost unbelievable adaptability in many industries, and the number of its uses is steadily increasing throughout America.

In fact, the trails of Presdwood cross and re-cross endlessly—from breakfast nooks to motor boats, from cooling trays for hot castings to the paneling of beautiful homes, from the packing cases in a New York warehouse to the movie scenery of Hollywood!

This is happening right along

Step into the offices of a great manufacturing plant located in Camden, New Jersey, and you will find that all of its telephone booths are lined with Presdwood.

Out along the highways of Pennsylvania you will again see Presdwood—in the form of advertising signs.

In Pittsburgh, more Presdwood—a large department store ordered 14,000 feet of it just a few weeks ago.

In Cleveland, and other Ohio cities, candy manufacturers are making use of Presdwood for starch trays.

A Wisconsin manufacturer has also standardized on Presdwood—for incubators. A Minneapolis concern is using it in making safety wheels for bathing beaches and swimming pools. Out in Los Angeles, as well as in the East, it is going into concrete forms.

Presdwood is used for bed-room screens and for barbecue stands, for invalid trays and for theatre props, for artists' boards and for display booths. It will give as dependable service for garage doors in a Chicago suburb as for china closets in a Boston residence or for fixtures in a Seattle delicatessen store!

Only a short time ago, the head of a fast-growing American industry sat in his office running an eager hand over the fine, smooth surface of Presdwood. Quickly he decided that it was the very thing he needed, and it is now standard material for the manufacture of one of his leading products.

Similar incidents are happening right along. The simple truth is that you have no idea of what you can really do with Presdwood until you have seen a sample and made a few experiments with it.

The advancement of Presdwood has been especially rapid in planing mills and wood-working plants. Kitchen cabinets, show cases, counters, radio boxes and tension boards, work-bench tops, cupboards, office partitions and shelving—these are but a few of the many additional things which are made of Presdwood. And new uses are being discovered almost every day!

Remember that Presdwood is not only *grainless*, but that it has greater moisture resistance than Nature's own material, is much denser, and is far tougher. Yet it contains no chemical binder; no foreign substance of any kind. It is simply genuine wood torn apart and put together again—genuine wood, and nothing else!

Presdwood is manufactured by exploding fresh, clean chips from guns. This is done at a velocity of about 4,000 feet per second. The long fibres thus produced are then packed into hydraulic flat bed presses and subjected to hundreds of tons of pressure. The finished product is cut by automatic machines into broad smooth boards of uniform thickness.

Advantages of Masonite Presdwood

Masonite Presdwood has an exceptionally smooth, attractive surface on the face side, and requires no paint for protection. It also takes any finish beautifully. It won't crack, check, split or splinter. It shows minimum contraction and expansion.

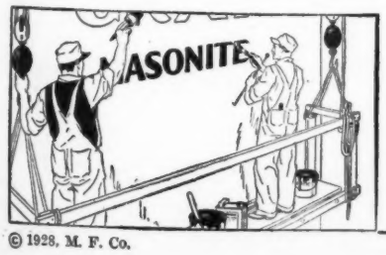
It contains no grit, and can not damage tools. It can be used on saw, planer, sander, shaper. And it comes four feet wide by twelve feet long.

We urge you to make your own tests and experiments with Masonite Presdwood. Only in this way can you find out what a really wonderful product it is. We will gladly forward you a large free sample promptly on request. Send for it to-day.

MASON FIBRE COMPANY

Sales Offices: Dept. 1258, 111 W. Washington St., Chicago, Ill.

Mills: Laurel, Mississippi

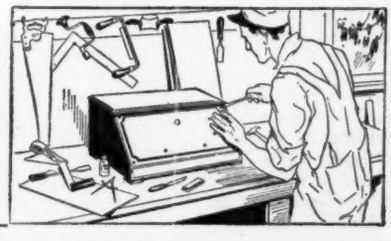


Masonite PRESDWOOD

Made by the makers of

MASONITE STRUCTURAL INSULATION

REG. U.S. PAT. OFF.



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Our Readers Say—

Brickbats and Bouquets

"WHEN you get ready to come down out of the air, I'll read POPULAR SCIENCE again. One item telling how to fix a leak in the bathroom plumbing is worth more than all the pages of aviation hokum you print every month. I have enough to do on the ground without thinking about wings."—D.M.C., Spokane, Wash.

"Ever since boyhood I have been a faithful reader of POPULAR SCIENCE MONTHLY, with the result that I have become a practical, versatile handy man about the house. It would be impossible for me to estimate the many helpful suggestions I have obtained from your magazine."—F. M. D., Utica, N.Y.

"Your use, at times, of medical propaganda and the slurs against drugless methods are a disgrace against human intelligence and justice."—V. H. R., Chicago, Ill.

"My whole family, young and old, read POPULAR SCIENCE MONTHLY from cover to cover."—W. W. T., Preston, Minn.

It's Not So Simple

"I HAVE read so much recently about superchargers, and how they increase the speed and power of automobiles, that I have decided to build one to try out on my car if I can get enough details about it. In your December issue you showed the picture of one for an airplane, and I was just wondering if I couldn't make one something like it for an automobile."—F. C. D., Clifton Forge, Va.

An expert on the subject, to whom this letter was referred, wrote in reply:

"The construction of a supercharger for use in automobile motors is not a simple job mechanically. The rotors of a supercharger operate from 30,000 to 50,000 revolutions a minute, and the mechanical construction, in order to obtain this speed without danger of vibration, must be extremely fine and special material must be used. I would not advise any individual to tackle a supercharger."

From Our Shipbuilders

"I HAVE just finished reading an English version of Columbus' description of his first voyage, and in it he tells of 'setting the spritsail.' I notice that in your blueprints of Captain McCann's model of the *Santa Maria* no such sail is included, and I want to call attention to this."—R. H., San Francisco, Calif.

"You may be interested in the picture of the Spanish Galleon inclosed, as it was cut out and assembled entirely with one hand by one of your readers, R. A. Edwards. The work was all done with a pocketknife and small coping saw."—W.S., Williamson, W. Va.

"Some time ago I bought a set of your blueprints of the Toy Motor Boat Cruiser. I have finished it now and have sailed it in a lake and it runs perfectly and does not list."—J. T., Wellesley, Mass.

"If you'd publish a little more stuff for the men who like to tinker with tools, instead of giving us so much fiction and radio dope, your magazine would fill a greater want."—A. R. F., Truro, N. S.

"I want to express my appreciation of the clearness and completeness of your plans of the *Constitution*, and to thank you for many hours of pleasant work. I knew little about ships; had never made anything in my life; I had no tools but a coping saw, a three-cornered file and plenty of razor blades; and lastly, I made the whole ship lying on my back in bed. So great was my interest in my work that I forgot my troubles and the diversion improved my health."—J. M. de V., Malone, N. Y.

The "Hams" Say Hello

MR. ARMAGNAC'S article "Triumphs of Radio Hams" in our March issue brought many QSL (acknowledgment) cards from amateur operators in many states, each card bearing the station letters of the sender.

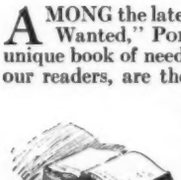
"I notice reference to my contact with 1BEB at Montpelier," writes Arthur Kent, of Binghamton, N. Y., one of the heroes of the Vermont flood. "This was a lucky strike, and I feel that in a small way I was of service. It might interest you to know that I am fifty-four years old, so don't get discouraged over old age."

"Sure enjoyed reading your article. Sounds good to all us boys."—W. O. Ansley, Jr., 5SP, Abilene, Tex.

"Being a ham, I would like to see articles relating to hams and their work in your magazine more often. Your magazine has proved very interesting to me."—Gerald Lovins, 9CSR, Denver, Colo.

What Do You Want?

AMONG the latest contributions to "What's Wanted," POPULAR SCIENCE MONTHLY'S unique book of needed inventions suggested by our readers, are the following, contained in a letter from S. G. Y., of Barboursville, W. Va.:



"Automobiles run by electric power picked up by an aerial the same as in radio.

"An invention to eliminate the 'click-click' of car wheels over rail joints, and so make riding on a train like riding in an auto.

"Airplanes large enough to carry many passengers, or, in time of war, to mount as many as six guns."

"What's Wanted" is kept in the library of our offices, 250 Fourth Avenue, New York City, where it is available for reference.

A Great Idea!

"WHAT do the ladies do with their old hat pins, now that their hair is short and their hats are tight? I'll tell you what I do with them. It's myself don't like feet sticking out of bed covers at night. The covers would always pull up. So now I stick three or four hat pins through the covers into the mattress."—P. G. M., Palm City, Fla.

Who Holds World's Record?

"A MAN who likes to argue asked me the other day: 'Who holds the record for an airplane trip around the world?'

"I replied that the record was held by the Army pilots who made the round-the-world flight several years ago.

"'You're wrong,' he said. 'Commander Byrd holds the title. At the North Pole two years ago he flew all the way around the world in a few minutes!'

"And when I protested that Byrd didn't really circle the circumference of the globe, even though he did return to his starting point, my friend glibly retorted: 'Neither did the Army flyers; they only flew around the Northern Hemisphere.'

"So according to this, a real round-the-world flight—one around the earth's widest girth—is one remaining stunt for aviators to shoot at."—A. L. B., Detroit, Mich.

Settled at Last!

"REGARDING your readers' controversy over back-seat driving, will say I have solved the problem satisfactorily. Simply bought a roadster for two—no back seats, not even a rumble. Please send by return mail your regular ten-dollar prize for best automobile idea of the month."—J.J.B., Columbus, O.

Mystery in Gray Heads

"I HAVE often heard stories of men whose hair turned white overnight as a result of sudden great fright or shock. Always I thought such tales were manufactured out of whole cloth, until a chemist assured me that this strange transformation sometimes does happen.

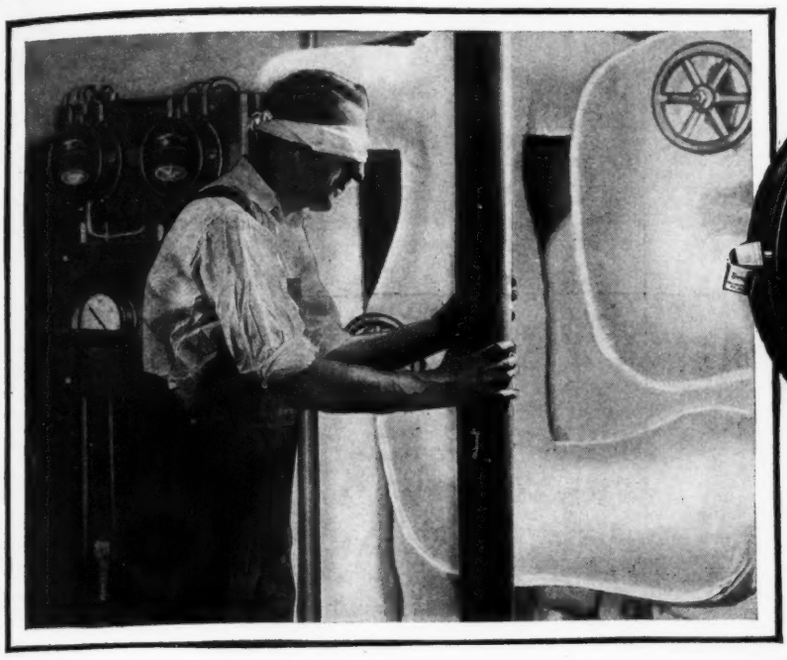
"It has been discovered, he told me, that in our bodies are certain curious white corpuscles called polymorphs. Under great mental stress, as during a battle, these corpuscles sometimes escape out of the blood stream, wander through the body tissues and even go up through the centers of the hairs, where they quickly eat out the coloring matter."—A. D. B., Phila., Pa.

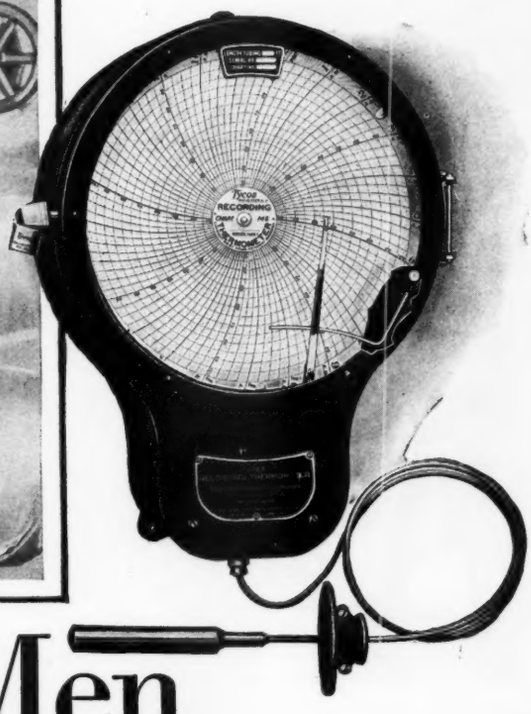
What Shall We Eat?

MANY readers have expressed as many conflicting opinions on T. Swann Harding's article, "What Doctors Don't Know about Diet," in our February issue.

"I am sorry to see an article so far from the truth," writes J. C., from Toledo, O. "Mr. Harding talks like a paid emissary of the meat combine. Many people have found freedom and health through vegetarian diet. I have been a vegetarian for many years. I am forty-two years old, work at engineering work ten hours a day, and am as near absolutely well as a person can be."

On the other hand, Dr. E. W. B., a physician of Farmland, Ind., writes: "I agree with the article exactly. Food faddists on diet need to be tied up; for awhile, at least."





Blindfolded Men

couldn't tell the temperature within Forty Degrees—

THE Superintendent of one of the largest Cold Storage Plants in Chicago says:— "As in all plants of this type the ammonia gas on the compression side of the ammonia compressor must be kept at a certain temperature. Formerly the engineer controlled the temperature by feeling of the pipes with his hand and adjusting the expansion valve to the point that seemed 'about right.'

"Three years ago we installed a *Taylor Instrument Companies'* recording thermometer to replace this crude and unsatisfactory method. As a test we covered up the dial, forcing the men to operate as before, simply by their sense of feeling. The results showed that this old method was even more inaccurate than we had suspected:—

the temperature fluctuated as much as 40 degrees both above and below the efficiency point.

"When the temperature is allowed to vary as it formerly did, a great deal more water is required for condensing the gas. By watching the dial on the *Tycos* Instrument the engineer can now keep the temperature variation down to 2 or 3 degrees. We do not keep an exact record of the amount used, but a 20% saving would be a very conservative estimate of the proportion saved by installing a *Tycos* Recording Thermometer. The *Tycos* instrument saves its cost each month."

You, too, may be able to make a similar big saving in your plant by installing *Tycos* Instruments. Informative literature on any of the 8,000 varieties of *Tycos* heat indicating, recording and controlling instruments will be sent you on request. Or our engineer will consult with you on the application of *Tycos* to your particular manufacturing problem.

Tycos for the Home

Tycos Office Thermometers
An aid in promoting human efficiency.

Tycos Bath Thermometers
To enable you to get the most good from your bath.

Taylor Home Set
Bake Oven Thermometer, Candy Thermometer, Sugar Meter. The secret of accurate results in Cooking.

Tycos Wall Thermometers
To help you maintain a temperature in your house conducive to good health.

Taylor Quality Compasses
To show you the right way in unfamiliar country.

Tycos Fever Thermometers
A necessity in every home.

Tycos Stormoguide
Forecasts the weather twenty-four hours ahead with dependable accuracy.

Tycos Hygrometer
To enable you to keep the humidity of the atmosphere in your home correct at all times.

Tycos for the Medical Profession

Tycos Sphygmomanometer, Pocket and Office types.

Tycos Urinalysis Glassware.

Tycos Fever Thermometers.

Your dealer will show them to you. Ask us, on a postal, for booklets on any of the above.

Bulletins on Request

Taylor Instrument Companies

Main Office and Factory
ROCHESTER, N. Y. - - U.S.A.
Canadian Plant: *Tycos* BUILDING, TORONTO
SHORT & MASON, Ltd. Manufacturing Distributors in Great Britain

THE ~ SIXTH ~ SENSE ~ OF ~ INDUSTRY

Tycos Temperature Instruments

INDICATING ~ RECORDING ~ CONTROLLING

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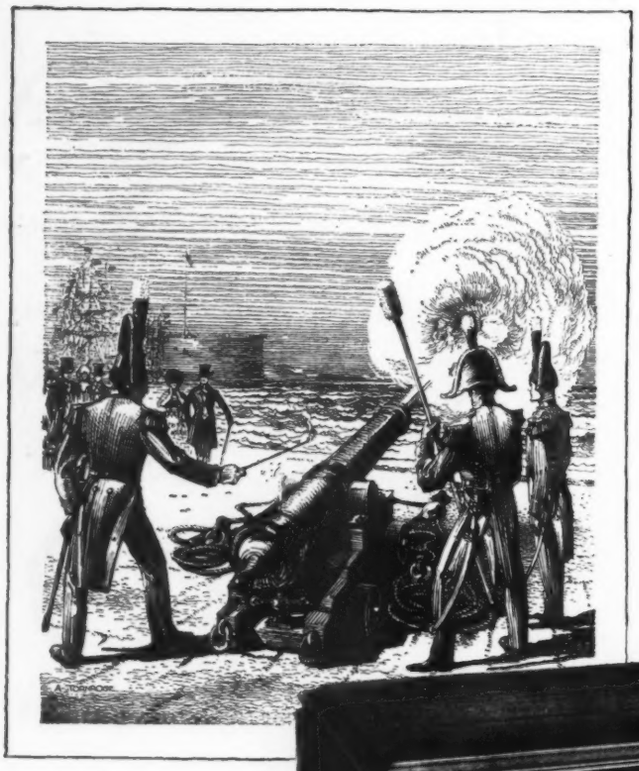

News of the completion of the Erie Canal on October 26, 1825, was passed across the state by firing cannon, placed at intervals, each being fired as soon as the nearest one was heard. The news thus traveled from Buffalo to the Battery in New York City in the amazing time of one hour.

Get it *Better* with a Grebe

GREBE RADIO
TRADE MARK REG. U.S. PAT. OFF.

Among true enthusiasts, probably no feat of present-day radio engineering has aroused greater interest than the Grebe Synchrophase A-C Six. Probably none has been awaited with greater expectancy—not from Buffalo to the Battery, but from Coast to Coast.

For those who appreciate real radio enjoyment—the utmost in tonal beauty, range and selectivity—have long since come to a realization that the nineteen-year-old Grebe method of slow, painstaking production has in each step of radio development resulted in perfection.

The Grebe Synchrophase A-C Six is no exception to the rule. With distinctive Grebe innovations it proves that there is as wide a difference between Alternating Current (All-Electric) sets as between those using batteries.

Grebe Synchrophase Seven, $145; Grebe Synchrophase Five, $105; Grebe Natural Speaker, $35; Grebe No. 1750 Speaker, $17.50.

Hear the Grebe Synchrophase A-C Six today, or send for Booklet P, which fully explains this new receiver.

GREBE SYNCHROPHASE
TRADE MARK REG. U.S. PAT. OFF.

A-C Six
RADIO

A. H. Grebe & Company, Inc., 109 West 57th Street, New York City
Factory: Richmond Hill, N. Y. *Western Branch:* 443 So. San Pedro Street, Los Angeles, California
Makers of quality radio since 1909

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Popular Science MONTHLY

FOUNDED 1872 — FIFTY SEVENTH YEAR

MAY, 1928 — SUMNER BLOSSOM *Editor* — VOL. 112, NO. 5

DICK BYRD — Adventurer

MORE Thrilling Than Fiction, the Vivid Story of the Real Commander Byrd Begins Here. In It Fitzhugh Green, Also a Distinguished Naval Officer, Lets Us Share His Lifelong Friendship. He Makes It Possible for Everyone to Know the Thrill of Conquest and to Ride to Romance with the Master Flyer

By FITZHUGH GREEN

When Commander Byrd returned from his historic flight across the North Pole, his proud mother was first among the throng to welcome him. This photograph was taken aboard the official reception boat of the Mayor of New York

"WHERE IS HE NOW?"

At midnight on June 30, 1927, at least 50,000,000 people all over the civilized world were intently asking one another that question.

The question referred to the American flyer, Commander Richard E. Byrd, then on his way from New York to Paris in his big three-engined monoplane, the AMERICA. With him in the plane were three companions. He had left New York at dawn the day before. By radio he had for thirty-six hours given a breathless world word glimpses of his machine roaring her way through fog and rain and darkness far above the stormy surface of the North Atlantic Ocean.

Now at dark on the second day there was silence. Where was he? Still aloft and alive—or completely swallowed up without a trace by the black waters of the sea?

"Our radio was all right," he said afterward. "The trouble was that everybody in Europe was calling us. We couldn't get a word through asking where we were. You see for awhile we were lost."

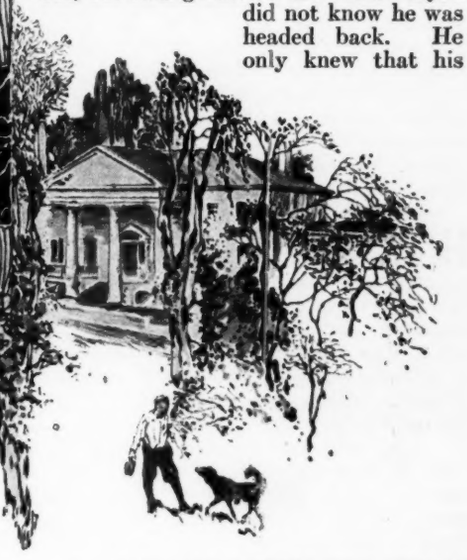
LOST.

Look at that little word all by itself for a moment. LOST in the jungle; but food and drink and trail can be searched for. LOST at sea, but still the wind and tide to carry one onward. LOST in the air—

Ah, that's another thing. For "lost in the air" means trembling on the brink of eternity. When Byrd says "We were lost," he also says in effect: "Because it was night and fog covered the earth, because our compasses had gone wrong, because our fuel was down to the last few gallons, and because we could not hope to bring our massive plane to earth at a speed of eighty miles an hour and expect to live, our case looked utterly hopeless."

The AMERICA circled frantically over Paris. Her motors were heard there by a score of reliable witnesses. But none aboard her saw the city through the black vapor that blanketed it.

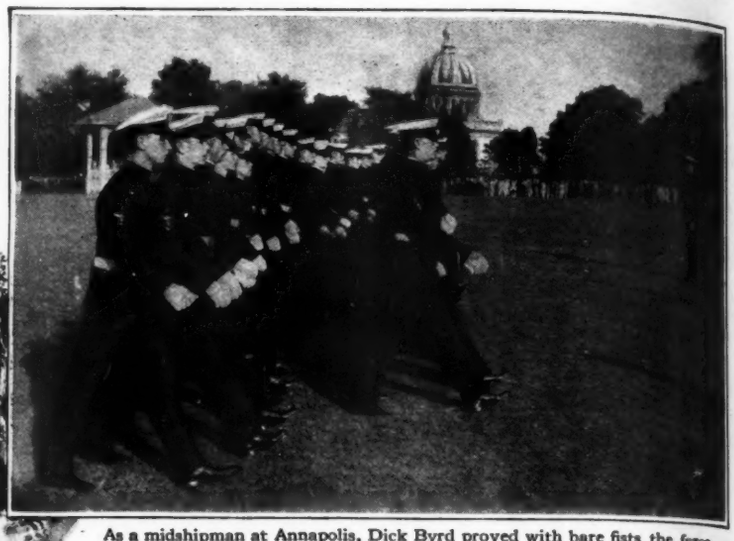
Aimlessly, because her compasses were out, she swung back to the coast. Byrd did not know he was headed back. He only knew that his gas was low, his visibility zero, and his altitude about 2,000 feet.



He came down several times as low as he dared to come. Once he thought he saw the flicker of a light. But all he gained from these maneuvers was a fuller knowledge of the sure destruction

that faced him if he attempted to land.

To get an idea of his predicament, just picture driving a seven-passenger limousine at eighty miles an hour across a rocky field bounded by trees and fences in PITCH BLACK DARKNESS. That's what a blind landing would have been like for Byrd on that dramatic night of June 30, 1927.



As a midshipman at Annapolis, Dick Byrd proved with bare fists the force that lay back of his retiring manner. Here are the midshipmen on parade

WHILE the world waited, and three wives wept, Providence took a hand. Through pure luck Byrd caught sight, hours later, of a faint gleam below him. Again he swung the AMERICA downward. By the light's changes he recognized it as a coastal beacon. This meant there must be water near it.

"We are going to land," he wrote on a slip of paper, and passed it among his companions. As the motors had been roaring for forty-two hours, none could hear. By a small hand flashlight each, in turn, read the fateful words.

"We are going to die," Byrd might as well have written. For the chances were a thousand to one against bringing the plane down even if there were water in the gray murk below her.

In broad daylight it is the hardest thing in the flying world to do, to estimate exact distance above the surface in a water landing. Now Byrd was going to do it in the dark. Further, the AMERICA was a land plane. All knew, too, that water could be like concrete if struck solidly at high speed.

The simplicity and courage with which Byrd faced the inevitable seemed to steel his men to face it likewise. All sat quietly and did their duty to the last.

When the plane struck, the impact with the water sheared off her powerful steel-braced landing gear as if it were made of cheese. The next instant the concussion of her crash stunned those aboard her into a momentary unconsciousness.

Hours passed before the waiting world knew that the flyers still lived.

BUT more vital to our story is the fact that when Dick Byrd was called upon to face that terrible crisis and decide his own fate, as well as that of the brave men with him, he had had only two hours, sleep in three days. He was worn by weeks of overwork and nervous strain. Deafening vibration of the three motors had been tearing away at his nerve fibers for a day and a half. For twenty-one hours he had seen neither sea nor land nor sky, which alone seemed to sign the death warrant of the party. Yet he thought straight and acted correctly when the fateful moment came.

How is such superb self-control and courage to be accounted for in any one man? What traits of character bring a superhuman will to bear in circumstances as terrible as these?

Luckily, with Dick Byrd we have a long family record that throws much light upon his case.

In the first place, he is a "Byrd of Virginia" as history goes. In his veins courses the blood of a distinguished line that runs back five centuries through English, Irish, Scotch and French progenitors; a long line of aristocrats; fine men used to fighting, to duelling and to giving orders; men who had put some kings upon their thrones; and by the same bloody swords had taken others off.

The first American Byrd was bluff old Colonel William who landed on the shores of the James River in 1671. It is related of him that as he strode up the crude dock he thought a certain red Indian too insolent in his stare. Whereupon he planted himself fearlessly in front of the armed aborigine and gave him a piece of his mind in a tone that could be heard clear to the backwoods half a mile away.

Then there was Francis Otway Byrd, a fiery royalist. "DAMN YOU, COME ON!" he bellowed in 1775 to a score of Yankee rebels against his English king. He had every intention of meeting them single-handed. Prudently they left the choleric gentleman to vent his spleen on the empty air.

Yet some Byrds fought in the Revolutionary War, in the War of 1812, on both sides of the Civil War, and in the Spanish-American War. In the late World War, Captain Tom Byrd, Dick's younger brother, was officially decorated for his help in breaking the Hindenburg Line.

Facing death is no new ripple in the current of Byrd blood.

But because these ancestors of Dick Byrd's were gentlemen, they were also often dandies. They knew rare wines and loved fair young women. They carried themselves with grace and they bore the touch of the thoroughbred about their grooming.

So it is that Dick Byrd combines today the charm and grace of the cavalier with the daring and enterprise of the crusader. And equally so it is that in the face of danger he does not seem to know the meaning of normal fear.

DICK BYRD was not exactly born with a gold spoon in his mouth; but certainly it was a silver one. The old Byrd home called Westover, built 300 years ago below Richmond on the River James, still stands. The mansion is a monument to luxury and extravagance. It is a superb place yet—secret passageways, vast wine cellars, imported mahogany paneling and paintings of the masters in exquisite taste.

All dressed up for his first command—Dick Byrd as a cadet officer at the Virginia Military Institute

But by the time of Richard Evelyn Byrd, senior, father of the present Tom, Dick and Harry Byrd, Westover had gone to richer owners. Mr. Byrd, Sr., was a lawyer and orator of first rank. He could have had the governorship of the state, as has his son Harry today, if he had chosen, but he stepped aside for a younger man.

Young Dick was born in his father's house in Winchester, Virginia, in 1889. He and his two brothers, Tom and Harry, even then formed an efficient gang of young daredevils. None dared tamper with a Byrd boy, or steal an apple from their orchard behind their house.

From the beginning it seemed that Fate did her best to tempt Dick into easier avenues of living than those which he has so boldly and insistently pursued.

After a grammar school education he became a student at the famous old Virginia Military Institute. He learned there to be a soldier by the same system

and under the same roof that had turned out the greatest generals of the Confederate Army. He could have entered the Army from the Institute as an officer and spent many comfortable years in the service of his country, had he so desired.

BUT Byrd is the kind that has to keep moving forward. At eighteen he became a student at the University of Virginia. He wasn't quite sure whether he would become a doctor and please his mother, or a lawyer and succeed his father. He would have done well in either, with his keen mind and happy presence. For a happy year he worked hard in the classroom and in betweentimes played star quarterback on the University team.

"Want to go to Annapolis?" his father asked him late that spring.

Dick's quick mind grasped at the word. It meant the United States Naval Academy on the Severn River; the nation's school for making naval officers. He knew that Annapolis graduates roamed the seven seas on Uncle Sam's men-of-war. Travel; adventure; prestige, Annapolis stood for. What boy could resist it?

"Sure!" cried Dick, even then the incorrigible adventurer.

He went, and in the summer of 1908 he became Midshipman Byrd, U. S. Navy. His delicate features showed to advantage, framed between a neat white middy blouse and a man-o'-war's-man's cap. He was quiet of voice and retiring of manner; but he had a certain CONVINCINGNESS about him that took.

For instance, one day a thoughtless cadet at the local St. John's Military Academy behaved in a careless manner toward the dignity and honor of the class of Annapolis just entered. To be specific, he shouted, "Oh, you plebe!" to a passing middy. To avenge this dire insult a member of the fourth class had to fight. Byrd, known already as a coolhead and a boxer, was chosen.

DOWN behind Old Quarters at Annapolis the fight was staged. Only two principals and four seconds were present. "Private-official" was the status of the fray; that is, a duel of fists for honor's sake. Queensberry rules, no gloves; a fight to the finish. And oh, how bloody! For bare knuckles cut and split.

Byrd and the St. John's cadet stripped to their waists. For all his slenderness and good looks, young Dick's shoulders were broad and his reach a good equal of his six-foot height.

His antagonist was shorter; stockier and not so erect. But he, too, was a clean-cut lad; and, by the build of him, sure to be the aggressor.

"Ready?" jocosely queried a second of the stocky cadet. "When do we begin to massacre?" his tone seemed to say.

Byrd answered by stepping forward. Whereat the cadet rushed, arms swinging and head down. Then, a little slowly but ever so surely, began to happen what usually happens when Byrd's solicitous friends watch him pit his seeming weakness against forces beyond him.

Simple enough in this case: Byrd could box, keep his head and out-think his man. He had had plenty of practice in "taking one on the beak." He knew what his own blood tasted like.

A sharp thud-smack ended the battle. Byrd's swift right caught the other's jaw straight across and slightly up. Like a sack of meal the jaw's owner dropped unconscious on the turf.

Today Byrd still looks too fragile to be an explorer. One forgets that he has had plenty of practice in "taking one on the beak" from gale and blizzard; and that he still knows by many a struggle "what his own blood tastes like."

TWO years later Byrd's athletic prowess and his previous training at the University of Virginia brought him to a position on the Navy football team. He was varsity quarterback and known throughout the intercollegiate world for his eel-like ability to gain ground when his most powerful backs failed.

In November, 1910, he had a tough break. That year Princeton had a veritable "tiger team," an aggregation of tooth-and-nail fighters.

President Coolidge, Commander Byrd, and Floyd Bennett, his pilot, at presentation of medals for their flight to the North Pole

Annapolis met Princeton on the former's home ground. Every Navy man in the fleet who could get leave came down to the old school to see the greatest contest of the year. And they were not disappointed.

For three quarters of the game the teams wrestled back and forth across the field. Then, with five minutes to play, Princeton began a march toward the Navy goal. On the six-yard line Navy held. Dick Byrd drove his team with a fury that was no longer human. But at this critical moment his line broke. The entire Princeton team seemed to charge through the hole.

Like a steel projectile Byrd's body met the oncoming torrent of bone and muscle —and stopped it. When the pile disentangled he could not rise. His left leg bones were broken in two places. But he had prevented the enemy from scoring.

A year later Byrd broke his leg again, this time with far-reaching consequences.

HE WAS now star member of the Navy gym team. After the end of the football season he devoted his time to developing new and hair-raising stunts for use against the various colleges which competed each winter with Annapolis.

To beat Yale that year meant winning the championship. To do this Byrd developed the "Byrd dislocation," a double whirl and catch on the flying rings, one of the most dangerous and difficult pieces of acrobatics ever tried.

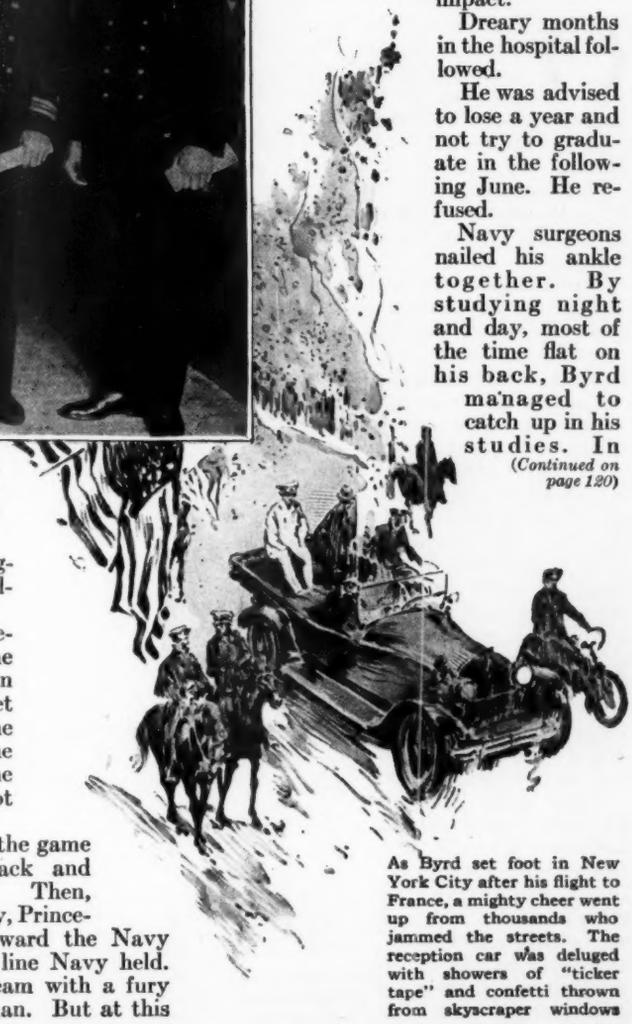
On the day before the big meet he went through his paces. The first time he succeeded beautifully in dislocating and spinning as he planned. The second time, while swinging almost to the lofty gym roof, he lost his grip. It was a gruesome sight to see the boy's body shooting through the air towards the hard floor beyond the mats. By the grace of God he landed on his feet. But again his left leg and ankle were shattered by the impact.

Dreary months in the hospital followed.

He was advised to lose a year and not try to graduate in the following June. He refused.

Navy surgeons nailed his ankle together. By studying night and day, most of the time flat on his back, Byrd managed to catch up in his studies. In

(*Continued on page 120*)



As Byrd set foot in New York City after his flight to France, a mighty cheer went up from thousands who jammed the streets. The reception car was deluged with showers of "ticker tape" and confetti thrown from skyscraper windows

Whizzing at 100 Yards a Second!

The *Bluebird* "creeping" at a hundred miles an hour in preparation for the record dash

Growling Like a Mad Giant, a Squat, Finned Automobile Roars to a New World's Record of More Than 206 Miles an Hour

By CARL HELM

ON THE smooth hard sand of Daytona Beach, Fla., a few weeks ago stood a low, squat machine, the like of which was never before on land or sea.

It had the round blunt nose of a whale. Its tail was a great white fin. A calm, smiling man climbed into it and gave it life. It growled like a thousand mad giants. Down the beach it flew like the wind.

Five thousand spectators watched and thrilled. A deafening roar—a blurred flash—the roar died. The metal monster stood lifeless again, five miles from the start. Captain Malcolm Campbell, British automobile ace, and his *Bluebird*—such is its gentle name—had broken the world record for speed on land.

He had made 206.95602 miles an hour by official clocking of the American Automobile Association. A mile in 17.395 seconds! His tachometer, he reported, registered 220 miles an hour when he crossed the finish line—a rate under seventeen seconds a mile. He had beaten by 3.164 miles an hour the previous record, held by Major H. O. D. Segrave and his British *Sunbeam*.

Three days later an American youth, Frank Lockhart, went after the new record. He sent his little bulletlike car streaking at 225 miles an hour, unofficial, but as it entered the measured course it swerved and plunged into the ocean. Rescuers pulled Lockhart out a hundred yards from shore. He almost paid with his life.

The next day the car of another American record seeker burst into flames and was driven into the surf to prevent greater disaster. A third American car, 1,500-horsepower *Triplex* of J. M. White of Philadelphia, was barred for its lack of the reverse gear prescribed by A. A. A. rules.

CAPTAIN CAMPBELL'S record stands—until somebody else goes a few seconds faster!

But why all the hurry? What good comes from these amazing speed contests? How is mankind or science benefited? Sixty to seventy miles an hour is about the limit of the average driver's ambition. Laws and the exigencies of traffic make even fifty miles hazardous. What difference does it make, then, if somebody proves he can drive almost 207 miles an hour?

Captain Malcom Campbell, who set a record of better than 206 miles an hour with his *Bluebird* and says he'll do 300

Your own car, be it flivver or limousine, will answer. With each new year and new model, you ride in increased comfort and pleasure and for less money. But almost a score of men, since the automobile was invented, have sacrificed their lives to make that so.

The history of the motor car has been made on the race courses of the world. The "Knights of the Roaring Road," most of them dead or forgotten, have made it possible, in part, for the man of average means to own a car. Two of them at least, Ralph Mulford and Louis Chevrolet, became great automobile engineers.

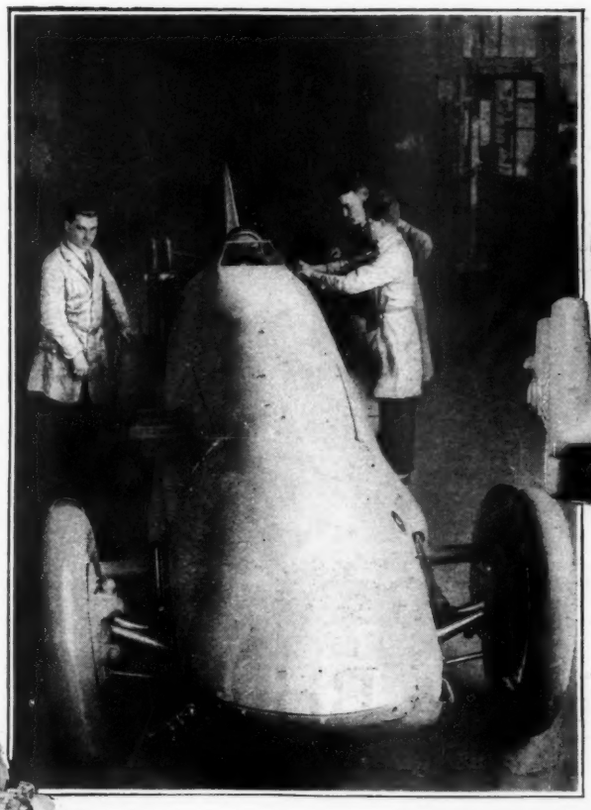
Races and speed contests form the laboratory of automotive science. Engineers with their blueprints may theorize; the speed drivers, casting dice with death, prove or blast their theorems. There is hardly an improvement in the automobiles of today that cannot be traced to the hazardous game of the kings of speed. Their

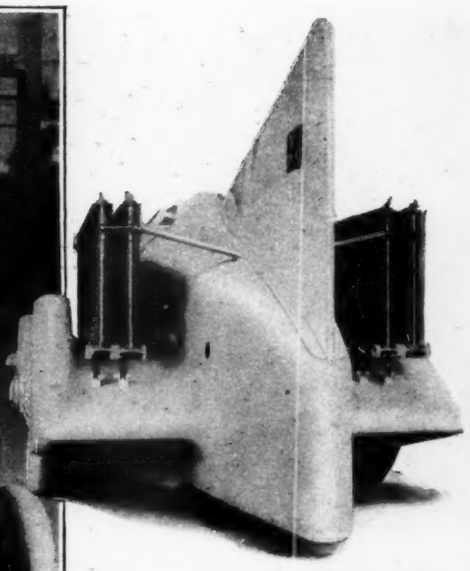
Frank Lockhart, American challenger, and a photograph of the sad end of his effort to beat Campbell's record. Going 225 miles (unofficial time), he plunged into the surf. Driver and car are shown being dragged out

brilliant, often tragic exploits have produced four-wheel brakes, balloon tires, eight-in-line engines, quicker getaway, acceleration, flexibility—and, perhaps greatest of all, inexpensive but efficient construction.

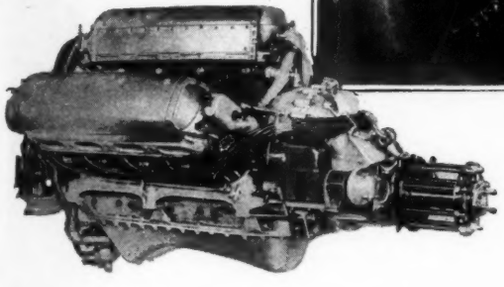
The first important speed contest on record was held in the spring of 1895—from Paris to Bordeaux and back, a distance of 744 miles. It was won by M. Levassor, a manufacturer of woodworking machinery, in a four-horsepower, pneumatic-tired Panhard car, with an average speed of 15.4 miles an hour. Observers said his "recklessness" in driving at that dizzy rate won the race.

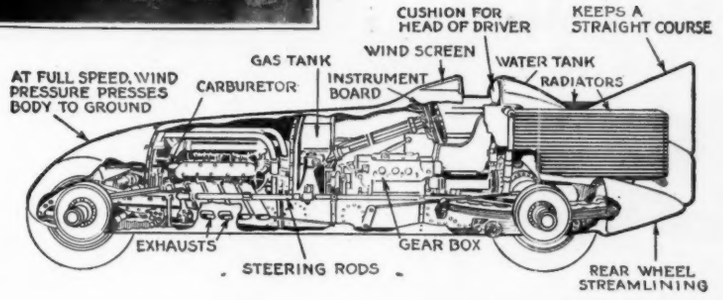
The doughty Frenchman considered himself more a sportsman than a "speed demon," and held his performance more thrilling than beneficial to mankind. But ever since the day of his triumph, racing has played an important part in the development of the motor car.





A side view of the rear of the *Bluebird*, showing the detachable fin provided to increase stability, and the radiators. Left: Front view of the 900-horsepower machine that cost Captain Campbell $100,000 to build. Its engine is similar to that which won the Schneider trophy for Great Britian in the seaplane races at Venice





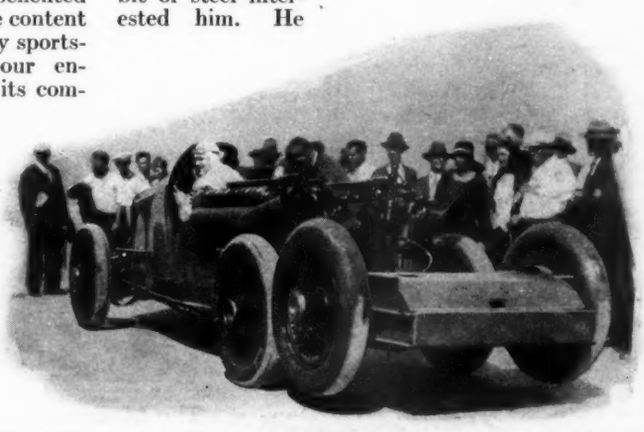
The 12-cylinder Napier-Lion engine of the *Bluebird*, motor car speed champion. It makes 3,300 revolutions a minute and weighs but .954 pounds for every horsepower developed. Right: Diagram of the car

The Gordon Bennett Cup classics in the early part of this century created keen competition in motor construction among the great scientific minds of the various countries. No more than three entries from a country were allowed, and every car had to be built entirely in the country of its origin. Thus French, German, English, Italian and American brains and skill concentrated on the same problems, and the automobile was developed through the involuntary interplay of ideas.

Undoubtedly the Americans benefited most. While the Europeans were content to leave the motor car to wealthy sportsmen and seekers of thrills, our engineers and manufacturers saw its commercial possibilities — and that is where the average car owner of today comes in.

In 1905 an automobile speed contest was held at Palm Beach. Europe sent its best cars and bravest drivers. It was still almost completely a question of sport in those days. The automobile was still a "horseless carriage," somewhat of a luxury for the man of means. It happened that among the spectators was a quiet, thoughtful little man by the name of Ford. While the rest of the crowd was yelling off its excited head, Mr. Ford was thinking. There were screams, a crash. A French car turned over. After the furore Ford picked up a valve strip stem from the car, examined it, and asked what it was made of. Nobody seemed to know. Ford took it home with him and found out.

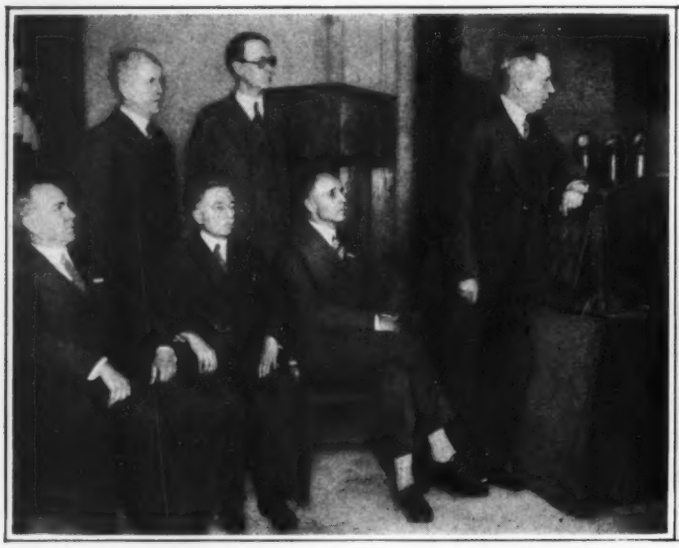
HENRY FORD had recently organized his motor car company and was aiming at inexpensive quantity production. That was one reason the small bit of steel interested him. He discovered that it was mixed with vanadium. The use of vanadium steel as the chief metal for working parts in American motor cars dates from that day.



The *Triplex* of J. M. White, barred from the speed trials despite its builder's effort to bring it within the rules by a special reversing device hung at its rear

Captain Campbell's record-breaking *Bluebird* introduced and proved new departures in engineering and construction which probably will have their effect in the automotive industry. He borrowed both the heart and the wings of the airplane. The Napier-Lion engine is similar to that which won for England the Schneider trophy in the seaplane races at Venice. That will interest engineers. His system of air vanes and the great fin of a tail to overcome air resistance will interest manufacturers, constantly seeking to cut down fuel consumption of the ordinary car.

Captain Campbell believes his *Bluebird* capable of 300 miles an hour on a concrete track. There seems little doubt that engineers can build still faster cars. But there is considerable doubt that human beings can drive them. Von Helmholtz, German physicist, found that a nervous excitation travels from 147.6 to 180.4 feet a second. Campbell's car attained 300 feet a second, faster than his brain could order a muscle to move!



Trans-Atlantic Radio Joins Two Conventions Electrical engineers in London and in New York recently held a joint convention by use of a radio telephone double hook-up. Bancroft Gherardi, American, at microphone

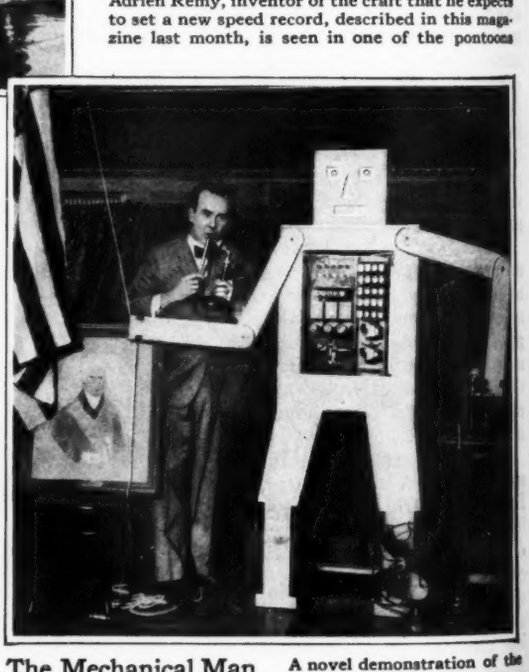
S-4 Salvage Project Uses Model Pontoon On tiny models of the huge devices that will lift the lost submarine, salvage officers and divers at the scene examine the operation of the valves and other operating equipment

News the Camera Brings

Flight in Aged Plane Shows Aero Progress To contrast modern aviation with that of the past, Capt. H. C. Richardson, of the Navy Bureau of Aeronautics, seen ready to hop, recently flew this obsolete, 16-year-old Curtiss seaplane at the Anacostia Naval Air Station

Pontoons of 60-Hour Atlantic Boat Adrien Remy, inventor of the craft that he expects to set a new speed record, described in this magazine last month, is seen in one of the pontoons

Relics 3,000 Years Old Dug Up Near Berlin Petrified bones, curious implements, and fossilized remains of human bodies, believed to indicate a civilization of 3,000 years ago, were recently found at Lossow, Germany. Here they are being classified for scientific study



The Mechanical Man Shown by His Maker A novel demonstration of the device, described in our January issue, with body, arms and legs for humorous effect

A jackhammer, driven by compressed air, being operated by a Moor in one of the extensive Riff mine operations in North Africa

New Wizardry of *Compressed* Air

A Fascinating Story of a Giant Strong Enough to Probe the Earth and Gentle Enough to Perfume a Lady's Handkerchief

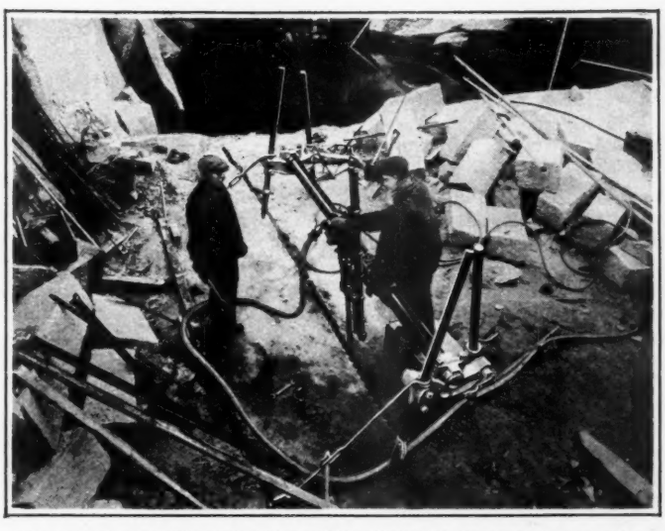
By Robert E. Martin

RAT-A-TAT-TAT! Compressed air drills, bucking mechanical animals with iron bodies and rubber-hose tails, shattered the quiet of the narrow tunnel. Beneath flood lights that bathed the jutting rocks in a weird glare, three score men toiled and sweated. Up ahead, thirty bounding metal rods in a ring-shaped frame bit and chewed at the blank wall that terminated the passage they were boring beneath a mountain peak.

Eight, nine feet deep the probing rods chattered their way into granite. Then silence, save the scurrying of feet as men raced back half a mile toward sunlight and safety. A dull boom, and blasting gelatin clinched the eight-foot victory they had won from the unyielding mountain.

"There's a mark for them to shoot at!" It was the foreman speaking. His gang had set a new world's record. In less than thirty days their drills had cleaved one thousand, one hundred and fifty-seven feet of eight-by-nine tunnel in solid rock!

By next October, it is expected, trains will be running through the eight-mile Cascade Tunnel, America's greatest, that dives into the Rockies at Berne, Wash., to emerge near the city of Scenic far to the west. Already, working inside and into the mountain from starting points all along the "pioneer" shaft that this record-breaking gang helped to pierce, men have dug alongside it nearly four miles of the full-sized main tunnel. As this is written, more than a third of the Cascade bore is lined with its tubular shell of concrete and ready for electric trains that will race through it.



Compressed air drilling holes that will be filled with dynamite in quarrying operations in New Hampshire. One of the myriad uses of harnessed air

Compressed air is literally blowing that tunnel through the Rockies. It races through air hoses, a leashed tornado of energy, to hurl itself against granite in the clattering rock drills. In huge "concrete guns," it spurts a plastic mass of gray-white lining into the circular forms that bridge the tunnel's roof. Through a hundred-odd devices of man's ingenuity, this powerful servant is driving to completion a tunnel that, without it, would have been a hopeless undertaking. In the time it would take two men with sledge hammer and hand drill to chip a hole a foot deep, for instance, the man with a modern compressed air drill has advanced twenty-five feet!

FEW of us realize what we owe to this magic, pulsing gas that engineers have tamed and put to work for us. Little bubbles of air, jammed together, crowded, and thrust through prisoning tubes, are the driving force that enters everywhere into our daily life. From the tiny atomizer that perfumes milady's handkerchief to the giant, 5,000-cubic-feet-a-minute air compressors that run shipyard riveters, machines of all descriptions bend it to purposes as varied

and often as spectacular, as in the great tunnel it is blasting beneath the Rockies.

The gold in your watch—the diamond in your ring—both were drilled out of the earth by compressed air. It cleans your fur coat and speeds your mail through underground tubes. Trains depend upon its mighty force to drag them to a stop should danger threaten, and to set the signals that warn of it. Compressed air mixes nitroglycerin and paints your wall. It sends torpedoes on their deadly missions and guards dams from the fury of driving ice. It aims and reloads great coast defense guns, and refines asphalt. Recently a startling new use has been found for leashed air. Towering waves were lashing the great oil pier at El Segundo, Calif., with the fury of a tempest. A previous terrific storm had swept half its length away.

Watching the breakers crash upon the shuddering pier, a tense-faced man in a little shore building stood beside a racing, chugging air compressor. Around a dial on its top crept a little metal finger—touched a mark at the end of the scale. The man threw a valve open, and air hissed through pipes that led to the sea.

THROUGH sheets of rain lashing the windowpane, he watched a miracle happen. Out along the pier, a minute or two after he turned the valve, the giant waves subsided. Where mighty breakers had threatened to destroy the vessels that had not had time to escape the storm's fury at the pier's edge, gentle swells now softly rocked them.

Little bubbles of air, streaming from holes in submarine pipes just laid near the pier, had tamed the mighty ocean. The jets, for all their airy origin, tripped up the waves and destroyed their force. The try-out in a Pacific tempest was successful; and today a number of these compressed-air breakwaters, invented by Philip Brasher, a Princeton, N. J., engineer, are saving thousands of dollars' damage to shipping and wharves along the Atlantic and Pacific coasts.

IT WAS more than fifty years ago that Alfred Ely Beach, New York City editor and inventor, installed beneath a downtown street a compressed-air underground railway tube of his own design. His novel subway car, driven the length of a city block and around a right-angled turn by a 100-horsepower blower, was patronized by hundreds of thousands of passengers in the single year of its experimental existence. That was the forerunner of the pneumatic mail tubes that speed your letters, today, beneath the streets of great cities at thirty miles an hour despite traffic-blocking storms and snow. In New York alone, for instance, letters shoot through twenty-seven miles of pipe to twenty-five branch post offices just as pneumatic cash-carriers bring you change in a department store. And at great railway terminals torpedolike, polished-steel projectiles that carry 500 letters apiece come hurtling through the pneumatic tubes with the last-minute mail to go aboard fast trains.

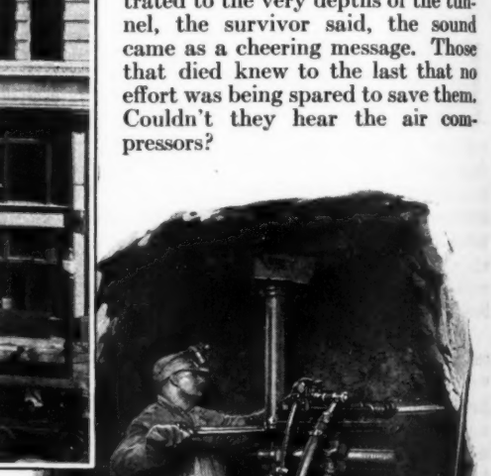
Above: Divers just come up from drilling holes for blasts to remove a rock ledge, dangerous to shipping, in the East River, New York. Below: Cleaning a skyscraper by compressed air, which blows sand against it

In an emergency compressed air may prove invaluable. One day a dredge dropped a heavy anchor and smashed the great cast-iron water main that dives into the bay at the lower end of New York to supply Staten Island with water. Engineers closed the gates at each end of the main and rushed to aid the thousands deprived of water. Compressed air, pumped into the broken main, blew out the mud and salt water that had filled it. Divers, breathing compressed air pumped to them through hoses, found that a new section would have to be welded into the pipe. It was done with welding torches fed by compressed air.

In all the annals of compressed air history, however—a history that goes back to the first primitive air machines that reduced ore to metals and forged iron and steel as early as 2000 B.C.—one incident stands out because compressed air actually played in it no part at all! It happened a few months ago, high in the Rockies, where men were working boring the Grizzly Creek tunnel.

Just at midnight, tragedy descended upon the six men in the shaft—tragedy in the form of an avalanche of talc rock, huge boulders, and crashing timbers, burying them alive. The oncoming shift sprang to the work of rescue, and H. V. Dardier, of the contracting firm, ordered:

"START the air compressors!" Men looked at him, amazed. The double length of air hose was frayed, torn, utterly incapable now of forcing air to the imprisoned men. But the compressors chugged away until, hours later, the prisoners were reached. All save one had perished. Dardier knew no air could reach the entombed tunnelers. But he also knew the terror that would grip the prisoners with not a sound of effort to help them. When he started the machines whose reverberations penetrated to the very depths of the tunnel, the survivor said, the sound came as a cheering message. Those that died knew to the last that no effort was being spared to save them. Couldn't they hear the air compressors?



Using compressed air to cut into the rock in works of the Gib Consolidated Mining Company at Basin, Mont., a method effective in copper mining

To Deliver Music by Wire

How the new "wired radio" service will carry national and local programs into homes which will receive them by plugging into electric light sockets

Apparatus Designed to Supplement Radio By Delivering Programs to Our Homes Just As Are Electricity and Telephone Service

By EDWIN KETCHUM

WITHIN the next few months radio broadcasting will enter an important new phase. It is wired radio.

While present broadcasting and receiving will go on as usual, elaborate new programs from an entirely new source will travel into American homes along the wires that supply light, heat and power.

With a special receiving instrument rented from your local electric lighting company, you can plug into any light socket and receive programs and the "juice" to run the receiving set.

This remarkable system, involving radically new inventions in transmitting and receiving instruments, is a development of the "wired wireless" or "line radio," invented some sixteen years ago by Maj. Gen. George O. Squier, U. S. A., retired, formerly Chief Signal Officer of the Army. Engineering research carried on at a cost of $2,000,000 during the last six years under direction of R. D. Duncan, Jr., has developed the idea into a practical system.

A subsidiary of one of the world's largest public utilities companies has completed plans for immense wired radio broadcasting studios in New York City, from which programs eventually will be supplied to wired homes in many cities throughout the nation. The receiving and transmitting instruments are being made.

The announced purpose is neither to supplant nor to compete with wireless broadcasting, but rather to aid in solving broadcasting problems by relieving congestion of the ether, eliminating interference, and simplifying reception. The old and new systems may be enjoyed side by side.

Briefly, the plan is this:

Programs picked up by microphones in the studios will pass over telephone lines to electric power substations in various cities. In each substation a high-frequency wired radio transmitter will send the signals out over the power lines.

The householder will pay a monthly rental ranging from $2 to $4.50, depending on the type of instrument. This will include installation and servicing of the instrument. Least expensive will be a simple crystal detector for use with headphones. Standard equipment will be a three-tube set, consisting of a detector and two stages of audio-frequency amplification, with a rectifying tube to supply direct B current to the set from the alternating house current. A loudspeaker will be included.

THE new wired radio receivers must not be confused with the ordinary "electric" radio receiver. The former detect only signals which come over the wires, while the latter bring in only signals from the ether. One cannot be used in place of the other. The engineers have, however, devised a means of connecting the special wired radio detector with any wireless receiver to make the latter serve as an audio amplifier. Present loudspeakers also can be used for wired radio.

Your present set, however, cannot be used to bring in the wired signals without the special detector. And it will be impossible to avoid rental by yourself building a detector. An instrument known as a "sound blocker," inserted in the electric supply line from the street, will block the signals to any one who does not pay for them, while still permitting the light current to pass into the house.

For subscribers who wish to receive both wired and wireless programs, there will be supplied a small wireless detector which, when used in connection with the wired radio receiver, will bring in signals from the ether.

Three programs will be sent out simultaneously on three separate telephone lines. At the transmitter in each power substation the telephone impulses will be impressed on three different carrier waves ranging in frequency from 20,000 to 60,000 cycles. These waves will go on the same wires with a three-phase, sixty-cycle lighting current of 2,300 volts, which will be "stepped down" by pole transformers to the usual 110 volts before entering the home. The main programs will run continuously from seven A.M. until midnight. Each substation will be in effect a small broadcasting station, capable of transmitting not only the main programs, but also such local programs as may be desired.

The desired program will be brought in by the subscriber simply by turning a selector switch to one of three numbered positions. This selection will be accomplished by filter coils in the set, which will block all but the desired wave length. No tuning adjustments will be necessary, for the set already will have been tuned in the factory to receive any one of the three radio frequencies.

THE limitation in number of programs will be more than balanced, it is announced, by unusual quality and wide variety of numbers on each. Present plans provide for an average of 510 numbers a day, including music of all kinds, lectures, sport events, news bulletins, stock market reports, weather forecasts, and so on. Special events such as boxing matches, football games and speeches by prominent men will be picked up through telephone line connections, as at present. (*Continued on page 137*)

The Electric Pilot

A Thrilling Episode in the Life of a Stunt Flyer, Whose Invention Led Him into Perilous Adventure

By Beryl D. and Orville H. Kneen

Illustrated by Harry Townsend

ON THE springy surface of his "high-flying ostermoor," Dick Warner rolled over luxuriously and for safety's sake grasped the edge of the upper wing. To the crowd a half-mile below, now merged into mere white splotches against the green of the fair grounds, he had been the foolhardiest of the air circus stunters. Times innumerable the "Human Skyrocket" apparently had risked his neck to put another crick in those of the thrill-hunters on the ground.

But Dick privately knew himself to be a cool and collected acrobat, who did his tricks a few thousand feet high because the higher the stunt, the higher the price. He drew deep breaths from the cool atmosphere, into whose deep blue depths the machine roared.

"Oy, what a life!" he remarked to the glistening surface of his old "Jenny." "Let's see—I've hung from the wing tip with one hand, made a plane change from wing to wing, another by ladder, done a cable-dip hand over hand, down and up—and I've given them the gr-r-reat head-down swing from the end of a rope ladder at sixty miles per. Now we'll do the 'living skyrocket' and call it a day—and I'll get in a few licks on my automatic control. Easy come, easy go, so here goes!"

Billy, his pilot, signaled that they had reached 4000 feet, and the plane banked sharply as it turned to circle over the field. With a roll and a flop, Dick shot off the steeply inclined wing into space. Those below could see him with binoculars as he turned over and over, as though falling unhindered into the hard arms of Mother Earth.

AVIATION owes an everlasting debt to the stunt flyers—those skillful daredevils who, probably as much as any other group of airmen, have promoted safety and confidence in flight. Lindbergh himself began his unequaled career with circus stunts far out on a trembling wing. As you read this story you will be doubly interested to know that its thrilling incidents are based on actual feats of stunt flyers, and that an invention like the one on which the plot hinges recently has been put to actual test in France.—*The Editor.*

AFTER a thousand feet of diving, end over end, Dick pulled the rip cord of his parachute and the little pilot-chute opened above him. Then, just as the big umbrella began to unfold, he pulled another cord which set off a smoke bomb, from which arose great black clouds. From around his waist he released red streamers which glistened in the sun like licking flames. It was a good stunt, he told himself, as he floated away from the field in a fifteen-mile wind. If he could work out that new combination with Billy. . . . He glanced at the field where the plane should be gliding to rest, but saw only wildly-rushing specks of humanity. He managed to twist a little in his harness, and even as his eyes lit upon the distant lake, a silvery shape plunged into its blue depths.

"Bill's down! He hit the only water there is, but even if he's lucky. . . ."

The head of the flying circus shook his head. "We can't show without the 'Skyrocket', Dick. The old Jenny must have had some weak spot. You can go up in Pete's ship—he'll soon get the hang of it, though it will be some time before he's as good as Bill was."

Dick was obdurate. "No use," he said. "You know I've been working on my automatic control, and somehow Bill's crashing seems to tell me it's time to get back to the drafting board. Too many good men coming down these days. . ." and he turned quickly away to hide—whatever it was he was trying to hide.

"Well, good luck then," said the chief, holding out his hand. "Lord knows we need something to steady the planes when the pilots can't. Make your gadget work, and I'll put you on again as Solo Dick, who drives his plane and does tricks at the same time."

IT WAS all of a year later that, from the shady depths of the Borden Airplane Company's engineering rooms, there floated a wisp of subdued song, which sounded much like that war-time ballad of the flyers:

"The motor's punk, the pilot's drunk,
The kid is sure to flop."

Jack Graves, company test pilot, listened a moment as he entered the door, followed by a girl much too pretty to be permitted to journey home unaccompanied.

"Nobody home," announced Jack, then, feigning to see Dick bent over his board, immersed in drawings and computations: "Why, see what the ground squirrels left. Figures, figures everywhere. . . ."

"But not a drop to drink," finished Dick. "You might as well run along—these figures are for more mature minds. But some day they will save some pilots from broken necks."

"By which time I'll have a long white beard to get tangled in the controls. Come on, Marian, let's leave the old pencil-pusher in his misery—only falling he'll ever do will be to fall asleep."

But Marian lingered.

"What about the specifications, Mr. Warner?" she asked gravely. "I'd be glad to come back and type that last page over."

"Thank you, tomorrow will do," said Dick, with a quick glance at the manager's secretary. Why, he thought, do managers allow such good looking secretaries around their factories? Not that it mattered to him, of course, but with the bums that one meets around such places. . . .

Jack Graves carelessly picked up a blueprint. "Automatic control—the pilot's delight," he sniffed. "Think of drawing good money for such monkey business!"

Dick flushed. Marian frowned at the pilot.

"You'll have a chance to try out the first model before long, Jack," she said. "It's going to be the making of this plant, as the boss told the president today." Then, turning to Dick:

"Mr. Burton is so anxious to get the plans finished that he told me to give you all the help you need from now on."

"FINE!" said Dick heartily, and shot a swift glance at Graves. "We'll soon be ready for Jack the High-Flyer, here."

"Buenos dias, old sport," retorted the latter as he turned to go. "A bird in the air is worth two on the ground."

Dick winced at the implied insult. He heard Marian remonstrate with the pilot as they went down the hall. "You know he was a famous stunt flyer only a year ago."

Jack's reply came faintly through the transom. "*Was*, all right. No pilot who hadn't lost his nerve would be wanting

these ding-busted automatic doo-dads—I don't."

Dick jabbed his drafting pen viciously into the board. "What Miss Caldwell can see in that—that . . ." and so on, far, far into the night.

But on succeeding evenings Dick frequently had an assistant in his labors, and as the plans and specifications progressed, so did their friendship, until he was addressing her as "Marian" without a blush. One day she explained the automatic control to Jack, who so far had exhibited supreme indifference to the secret device in all its phases.

"You just press a button for turning, gliding, or going up or down. The control does everything necessary to keep the plane steady."

"You don't say!" Graves responded. "And it takes off and lands too, I suppose?"

"Now Jack," she protested, "you know it can't do that. It only takes the pilot's place in the air, so that he can give more attention to navigating or to his plane."

"It can't be done," Jack mumbled. "A pilot has to have the feel of the air, and no combination of machinery, batteries and push buttons can take his place."

"Well, Dick has already tried out the first model on his own biplane and he says it worked without a hitch."

"No!" Jack cut in. "You don't mean to say he had the nerve to go up all by himself?"

Her eyes snapped ominously. "Dick's got as much nerve as anyone around here. Only he's using his head to save other people's necks."

"Dick? O, you mean Mr. Warner. Now Marian, I wouldn't hurt your pet engineer, but you aren't getting chummy with him, are you? You still like me, don't you?" He reached for her hand, but she put it behind her.

"I like you well enough, only you get so—so flighty, sometimes. Aviation means more than

From the swaying rope ladder Dick eased the inert burden from the tiny cockpit of the *Dragon Fly* and as the Jenny rose, Jack's body dangled in the air

The test pilot carelessly picked up a blueprint. "Automatic control," he sniffed. "Just think of drawing good money for such monkey business!"

just flying. And goodness knows, a test pilot who goes to parties like some I know, may have need of an automatic control some time."

"Aw, Marian, I only take a nip now and then. A fellow has to be a good sport—I can take it or leave it alone. How about a ride Sunday?" She hesitated.

"All right, I *do* want to learn more about piloting. But you can try leaving it alone for a change. Now I've got to get back to work."

When she entered the drafting room, Dick greeted her jubilantly.

"Just in time!" he announced. "One more copy of this sheet, and the final shop order can go out. Then we'll have our control installed in no time—or a few weeks at most."

"Don't you find it dull, designing, after stunt flying?" she asked, as her fingers flew over the keys.

"Well," he pondered, inspecting the drawing critically, "this has its thrills, too, and there's some satisfaction in feeling that you are doing something to make flying safer. My stunt partner Bill, who crashed out west, might be here today if we had been a little further along with the control. Did anybody ever tell you I quit stunting because Bill's crash made me lose my nerve?"

"O, no," said Marian, hastily, "Jack never said a word about it, and I didn't—er—wouldn't believe it anyway."

HE LOOKED into her earnest face admiringly. "You have helped a lot," he said. "You're a peach to give so much time to my dreams."

A few weeks later there was an air of excitement around the field of the Borden Airplane Company that was not due entirely to the stimulation of bright spring days. Dick and Jack Graves had been making test flights with the *Dragon Fly*, and the automatic control in the diminutive monoplane had worked perfectly.

Marian was inclined to triumph over Jack.

"Didn't I tell you?" she reminded him, as they stood in the hangar one noon hour. "Dick knows what he's doing."

"Yeah?" the test pilot queried gruffly. "It hasn't passed the Army inspector yet. If it goes haywire then, it's good night."

"Why, Jack, why should it go haywire? I listened in when you reported down over the radiophone this morning, and you said it was working fine."

"These complicated things always go wrong at the worst time. That's why I prefer to do my own controlling."

He pulled off his helmet and reached for his handkerchief to wipe his brow. A coin tinkled on the cement floor at Marian's feet, and she quickly picked it up.

"What a funny-looking penny—the sides have been filed off."

"Gimme that," he snapped.

"Why, Jack-the-easy-spender must be down to his last cent," she smiled. "Do you file it for reference?"

"It's my lucky penny," he replied, as he dropped it into the pocket of his flying suit. "I'd crash sure if I lost that. The filing on the sides is what makes it lucky." He sighed and reached for his hip pocket. "Gosh, I'm tired. Had to step out to a party last night, and then your nutty friend Dick gets me down here at eight A. M. to test out his electric pilot."

"WATCH your step," warned Marian, as she walked away, glancing sharply at the tiny monoplane parked in a corner of the hangar. "If anything happens on this test, you can look for another—friend," she finished quickly, and left him looking dazed.

Across the field she spied Dick rapidly approaching with the Army inspector. She waited until they arrived.

"Captain Perkins and I are going up, Marian," said Dick. "Then if it is O. K., Jack can take him up. The captain wants to see someone besides me operate it, of course. If it works as well as it did this morning, there'll be nothing to it!" He gazed happily at her, though puzzled a little at her downcast face.

With a rush of wind and dust from the propeller, the *Dragon Fly* roared down the field and took the air on sturdy wings. Dick started it into a rapid climb, while the inspector watched intently from the rear seat. Again the device worked perfectly, and the plane raced back and forth above the field, running steadily on an even keel, banking perfectly at the turns, and retracing its course without a tremor, guided entirely by the control buttons which Dick touched at intervals. Then he dropped the *Dragon Fly* a thousand feet, and repeated.

Twenty minutes later the little plane slid back to earth. The inspector was obviously pleased, though not yet ready to pass final judgment.

"All's well if it ends well," he remarked to Jack. "Ready for a whirl?"

"Up and at 'em," called the test pilot, climbing into the tight cockpit. He grasped the stick, taxied (*Continued on page 125*)

Risking Death for Science

No Story of Adventure Ever Written Is More Exciting Than These True Accounts of Men Who Experiment on Themselves

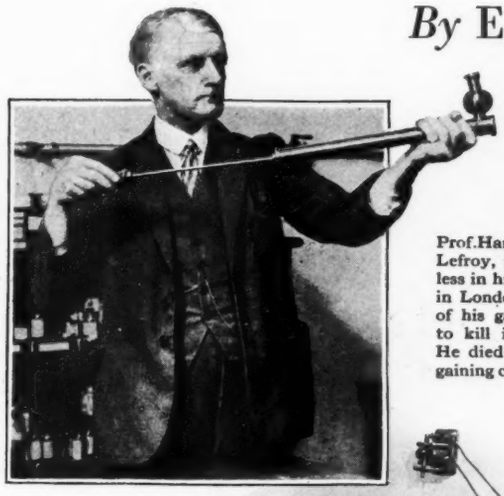
By EARL CHAPIN MAY

"GAS Kills Noted Surgeon."

Buried in the news columns, a few months ago, appeared that heading, with a brief announcement of the death, in Manchester, England, of Dr. Sidney Rawson Wilson, distinguished surgeon and anesthetist. No blaring headlines; only the short statement that the doctor's wife, entering his laboratory, found him with a mask over his face, lying before a machine which administered gas mixtures.

Yet between the lines was the heroic story of a martyr of modern science—one of many men who have sacrificed themselves to advance knowledge and mitigate human suffering.

For years Doctor Wilson had experimented with anesthetics to develop one which would prolong that "border" state in which a patient, though losing all feeling, still retains consciousness. Success seemed at hand. The only way thoroughly to test his results was to experiment on himself. He adjusted the gas mask over his face—and died.



Prof. Harold Maxwell Lefroy, found senseless in his laboratory in London, a victim of his gases devised to kill insect pests. He died without regaining consciousness

Dr. N. F. Fisher, of the University of Chicago, sleeps after remaining awake five days and four nights to determine the effects of sleeplessness over an extended period. An assistant is testing his pulse, blood pressure, respiration, muscular reactions and nerve responses in order to learn the details of his condition after the grueling experiment

IN MANY fields of science important discoveries have been given to the world by men who, like this surgeon, have dared to make themselves the subjects of their own experiments. In most cases they have done so in the face of danger and uncertainty as to the outcome; sometimes with full knowledge that the odds were heavy against them, and that death might easily follow.

As this is written, a distinguished ichthyologist of twenty-nine years, Van Campen Heilner, of Spring Lake, N. J., is sailing to the Bahama Islands on what may seem a foolhardy adventure. He proposes to offer his muscular white body as tempting bait for sharks, in order to answer the question: Will sharks attack and bite men?

Pure folly, one might say. But is it? For half a century naturalists have debated the shark's supposed fondness for human flesh. The question has remained undecided. Heilner believes that only one species, the white shark, is dangerous, and that all others are harmless. To find out, he will swim in the shark-infested waters of the Bahamas, risking life and limb, though armed with a knife against possible assailants.

Many experimenters have tried the effects of poisons on themselves. In tests conducted by Dr. Linn J. Boyd to determine how much of the poisons of insects the human body can absorb without serious suffering, fifty students in the New York Homeopathic Medical College volunteered to take daily doses in capsules of poisons of spiders, bees and other insects over a period of six months. Fortunately the results were not disastrous and a valuable contribution was made to medical knowledge.

NO SINGLE act of heroism during the great war surpassed that of Miss Mary Davies, Welsh bacteriologist who died in France a few weeks ago. She deliberately inoculated herself with gas gangrene germs to test a remedy for the terrible malady which killed thousands of soldiers in the early war days.

At this moment Sir Henry Hind, the world's leading authority on Parkinson's disease, is slowly dying in London, the victim of this mysterious creeping paralysis which he has tried for years to cure. Through his own experiences as a sufferer he is discovering new facts about the dread disease. Twenty years ago Sir Henry had the nerves of his left arm severed, in order to study the problem of paralysis first hand.

The necessity for self-sacrifice has been faced by scientists for centuries. In an era prior to artificial laboratory light the Dutch hero, Jan van Swammerdam, lost his sight experimenting with his crude sunlit microscope through which he revealed the anatomy of the honey bee. It was by conducting spectacular experiments on himself that Lazarro Spallanzani, an adventurous Italian of the eighteenth century, first revealed the processes of digestion which until then were deep mysteries. One may imagine the consternation of his horrified fellows when Spallanzani, determining to explore his own alimentary canal, boldly

John R. Kissinger, who as a U. S. Army private in Cuba risked death and permanently impaired his health by contracting yellow fever to study it

Dr. Linn J. Boyd and some of his "poison squad" of fifty students in the New York Homeopathic Medical College, who volunteered to take poisons secreted by spiders and other insects to determine their effects. The experiments, covering a period of six months, resulted in many discoveries for science. All the students realized their risks, but all survived with no ill results

swallowed linen bags containing bread. His friends frankly expected him to die of strangulation. What really happened was that when the linen bags had traversed the Spallanzani stomach the bread had been digested and absorbed.

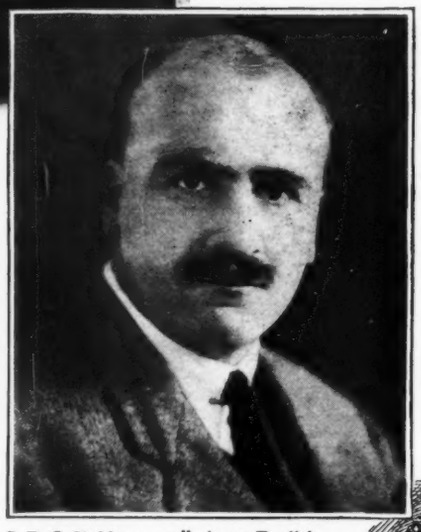
Now he swallowed little wooden tubes in which were bits of meat, bone, cartilage and tendon. And Spallanzani didn't die from this experiment. He learned that the meat, reached through perforations in the little tube, was digested by the stomach juices, while the harder substances were rejected, and cast out.

Only the other day, Vilhjalmur Stefansson, famous Arctic explorer, gave himself to experiments to settle the question whether a diet of fresh meat produces scurvy. With his personal physician, Dr. Eugene F. Du Bois, he entered Bellevue Hospital in New York City, where he planned to eat nothing but fresh meat, while submitting to daily blood tests for signs of scurvy.

SIR PATRICK MANSON took his life in his hands to prove that malaria was not a solely climatic disease. Importing malarial mosquitoes, he exposed himself to them in London and developed a severe illness of the disease. Happily, he was able to cure himself.

Every one should know the thrilling story of Dr. Jesse Lazear, the heroic American who, thirty years ago, gave his life to prove that yellow fever is contagious only because its germ is carried by a certain kind of mosquito. Dr. Lazear exposed himself to such a mosquito bite and died of "yellow jack." But largely through his self-sacrifice, the scourge of yellow fever no longer threatens the human race.

His historic experiments were recalled recently when the American Association for Medical Progress bestowed a belated reward upon John R. Kissinger, former private in the U. S. Army, a hero who likewise took a chance with yellow fever mosquitoes and became a lifelong cripple—all to save others. Following Dr. Lazear's death, the Walter Reed commission, of which he had been a member, and which was studying the disease in Cuba, required further proof that the mosquito was responsible. Kissinger volunteered and permitted five contaminated mosquitoes to bite him. Three days later he was raving with yellow fever. For weeks



J. B. S. Haldane, preëminent English scientist, who underwent vivisection to help surgeons devise a method of diagnosing and treating diabetes

he hovered between life and death. And though he survived, he never regained health. "In my opinion," said Dr. Reed at the time, "this exhibition of moral courage never has been surpassed in the annals of the United States Army."

The enervating hookworm might still have its own way in tropical and semi-tropical countries if Dr. Maurice Hall had not gambled with death by drinking a dose of carbon tetrachloride. His tests with animals indicated that tetrachloride did not harm them, although it harmed the parasite. Hall wanted to see if the effect on the human system was the same. He tried it on himself—and lived.

Sir James Simpson, who proved chloroform a successful anesthetic after making many experiments on himself and friends and relatives, who often were found unconscious, but survived

The German physician, Dr. Robert Remak, intentionally acquired and cured himself of ring worm. Suspecting a certain fungus of responsibility for this skin disease, Remak inoculated himself with the fungus—and so found it guilty.

So sure was Louis Pasteur that he could cure rabies, or hydrophobia, that he planned to inoculate himself. No one will ever know whether he would have been a sacrifice to science, because fate ordained that an Alsatian lad, Joseph Meister, should be brought to Pasteur suffering from a mad dog's bite. Pasteur cured the lad, who to this day shares fame with the great French scientific genius.

NITROUS oxide was looked upon as dangerous when Humphrey Davy, inventor of the miner's safety lamp, first experimented with it. The belief was that it made men unconscious, and might make them permanently helpless. Davy thought otherwise. He tried it on himself many times before he announced that "laughing gas" might be used successfully in dentistry and in other "surgical operations in which there is no great effusion of blood."

Sir James Simpson believed that chloroform could be used safely for surgical operations, but he had to prove it by trying it on himself, his relatives and associates. Quite often they were found unconscious, but they survived.

We might still be depending on chloroform, ether and "laughing gas" if Dr. William Crocker, a botanist in the University of Chicago, had not learned, fifteen years ago, that illuminating gas made carnations seem to "go to sleep." The gas contained deadly carbon monoxide and ethylene, which was suspected of being more deadly. Prof. Arno Luckhardt of the University and his associate, J. L. Carter, decided ethylene gas effects must be tried on a man.

Since Luckhardt was the elder and was married, Carter elected to take the chance. When he was unconscious Luckhardt turned off the gas. Within a minute Carter sat up and wanted to know why his associate hadn't gone through with the experiment. He had gone in and out of the influence without realizing it.

For many months Prof. Harold Maxwell Lefroy, in the Imperial College of Science and Technology, London, experimented to destroy larvæ of house flies with a vapor which he called "wood oil." One evening, when two friends visited him, he pointed to a bottle on a shelf and remarked, "I'm not going to touch that, for if it fell none of us would survive for a second."

A little later he was found poisoned by the vapors. He died without regaining consciousness.

Airplane view of the *Saratoga*, carrying 1,499 officers and crew, 115 aviators, and 88 planes. Her 180,000-horsepower electric plant with mighty turbines could supply all the needs of Boston

A Ship *That Can* Fight a Squadron

Our Cover Artist Tells Why He Painted America's Great New Airplane Carrier

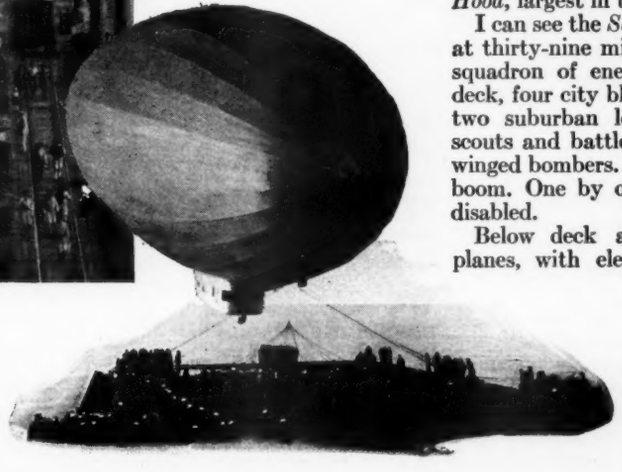
By HERBERT PAUS

WHEN the U. S. S. *Saratoga* was launched, she was merely an "airplane carrier" to me—just another big warship. But when, a few weeks ago, the dirigible *Los Angeles* successfully landed on her deck, my imagination was stirred. I wanted to see the *Saratoga* with my own eyes, and paint for POPULAR SCIENCE MONTHLY readers my impressions of this $45,000,000 marvel. On the cover of this issue I have tried to portray something of its colossal beauty and tremendous fighting power.

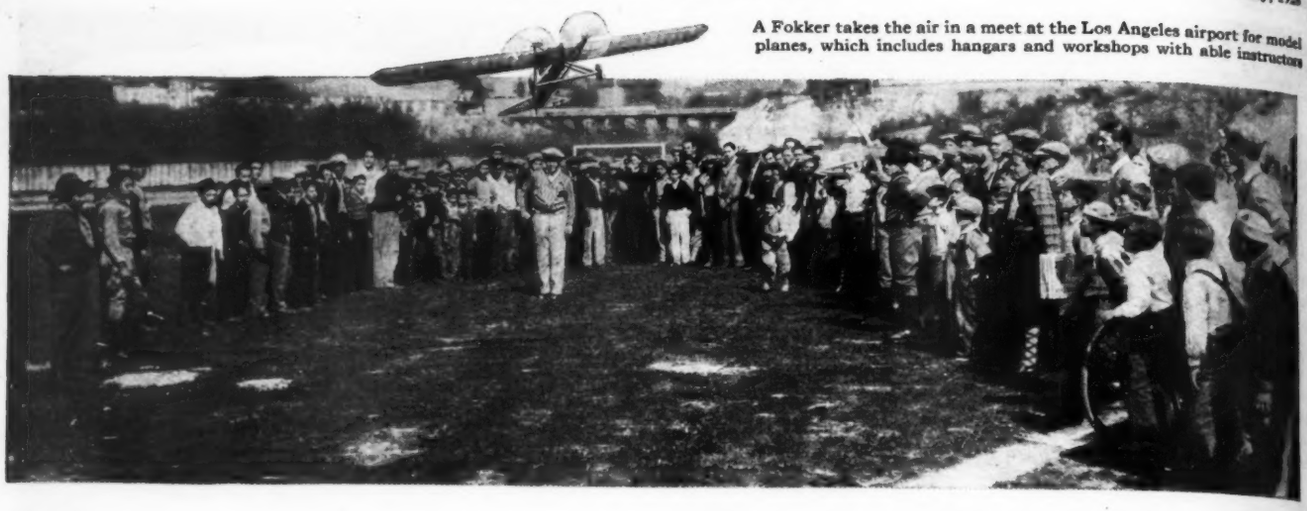
Both the *Saratoga* and her new sister ship, the *Lexington*, are the last word in fighting ships, comprising the swiftest and deadliest air-attack force in the world. Naval men tell me either might defeat an entire battle fleet. In speed, either could outdistance by more than two miles an hour the mighty British battle cruiser *Hood*, largest in the world.

I can see the *Saratoga* cutting the waves at thirty-nine miles an hour, attacking a squadron of enemy cruisers. From her deck, four city blocks long and as wide as two suburban lots, swarm eighty-eight scouts and battle planes and great wide-winged bombers. Her own eight-inch guns boom. One by one the enemy ships are disabled.

Below deck are hangars filled with planes, with electric elevators to hoist them. We can see gun turrets, superstructure, masts and funnel—all far to one side to allow a clear 880-foot sweep for planes leaving and returning.



The *Saratoga*, 106 feet wide, chipping off some of concrete walls as she squeezes through a lock of the Panama Canal, which has passed great ocean liners easily. If stood on end she would, with her 888-foot length, tower 96 feet above the Woolworth Building. At right: The *Los Angeles*, America's largest dirigible, landing on the *Saratoga*. The $45,000,000 airplane carrier has a launching catapult and elevators hoist planes from below-deck hangars



A Fokker takes the air in a meet at the Los Angeles airport for model planes, which includes hangars and workshops with able instructors

Young America *Finds Its* Wings

HAVE You Ever Flown a Kite or Tried to Launch a Toy Airplane? If So, This Article Will Bring Back the Old Thrill. With Aviation Now Taught in the Public Schools, Mr. Wheeler Sees in the Astonishing Achievements of Youthful Enthusiasts a New Picture of Our Aerial Future

By EDGAR C. WHEELER

IT WAS meeting day for the model airplane club at South Park, Chicago. A group of schoolboys had their heads together over a new miniature monoplane built by a member.

"What do you say to launching a parachute from one of these little ships while it's flying?" suggested a newer member. "Ever try it?"

"Hey, tell us something new!" exclaimed an old-timer. "Haven't we been trying to pull that stunt for two years? Try and do it!"

Standing a little apart, a dark-haired lad, smaller than the rest, had been listening silently. Now he stepped up and announced quietly:

"I think I see a way to do it."

"Yeah? Let's see."

"Next week I'll show you."

Next meeting day Eddie Marcouiller appeared with a model plane and a smile of triumph.

"Well, Eddie, what about the parachute?" they demanded.

Eddie said not a word. He wound up the rubber-band power plant of his little ship and up she soared, completing one graceful circle, and starting on another. Then suddenly a tiny umbrella dropped from under the wings, opened, and drifted slowly to the ground. The plane went on. With yells of delight the boys rushed to the miniature craft, when it came down at last, to learn the secret. They found that Eddie had rigged up a simple invention consisting of a small propeller placed beneath the fuselage in the wind stream of the main propeller, and a little trapdoor in the bottom of the fuselage. The parachute had been stored above the trapdoor, which had been held shut by a pin. From this pin to the shaft of the smaller propeller ran a slack thread. As the plane progressed, the revolving shaft had wound the thread taut, pulling the pin, opening the trapdoor and releasing the parachute!

Only a plaything.

Yes, but years ago two other boys, Orville and Wilbur Wright, played in the very same way with a toy flying machine. And out of their play grew the wonder of modern airplanes. Today, throughout the United States, thousands of schoolboys—and girls, too—are building and flying ingenious models of monoplanes, biplanes, seaplanes—driven by rubber bands and alarm clock springs. They, too, are scheming and inventing ways to make their creations fly ever farther, faster and steadier. They will be the air-

Winding up the rubber-band motor of a new plane at the airport and flying field provided by the Los Angeles Playground Commission. The port has for models all the equipment of the best real airport

Boys from Clearwater who took the prize for being the largest squadron in a recent California contest at Los Angeles. The planes, several of which placed in the competition, each had their own separate hangar

plane designers and inventors of the future, producing machines surpassing anything we can picture now.

As this is written, representatives of 15,000 school superintendents, meeting in Boston, are planning to make aviation instruction a part of the regular courses in graded and high schools—a proposal recently advanced by the Daniel Guggenheim Fund for the Promotion of Aeronautics. There will be textbooks explaining the principles and mechanics of flight, as well as practical instruction in designing, building and flying airplanes. And while these plans are in progress, there are being staged at least two great national model airplane contests in which youthful builders from many cities are entering their small planes and gliders.

A number of schools already have taken definite steps in teaching the young idea how to fly. Some have made the start in their manual training departments. In the Washington School in New York City, for example, boys from eight to twelve years old have just completed eight flying models of various machines, including Col. Lindbergh's *Spirit of St. Louis* and Commander Byrd's *America*.

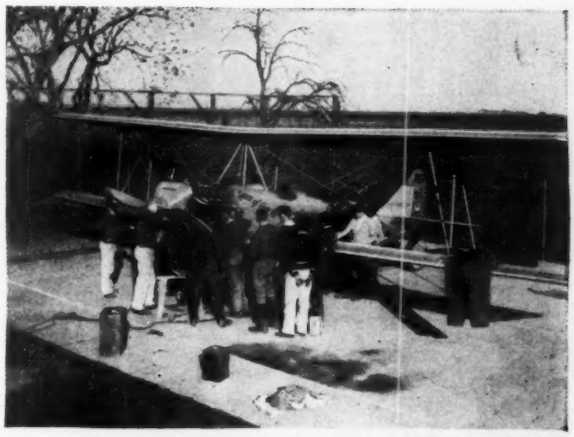
ONE or two schools have gone so far as to purchase full-sized planes for instruction in the theory and mechanics of flight and in actual flying as well. One of these is the Galt Joint Union High School at Galt, Calif., near Sacramento, where a four-year aviation course was started last fall. The course equipment includes a ninety-horsepower Eaglerock biplane with a cruising range of more than 500 miles. Students have christened the ship the *Spirit of Galt Hi*. In addition, there are two nonflying planes and eight airplane motors. All equipment was obtained from the U. S. Government, and was formerly used in the Army and Navy air services.

The first year of instruction covers physical geography in its relation to flying and elementary principles of aircraft design; the second, meteorology and engine construction and operation; the third, advanced design and aerodynamics; the fourth, more design and construction, engine operation and a full year's training in navigation and flying with an instructor. Altogether, the program is much the same as that followed in the flying schools of the U. S. Army Air Corps.

For the first year there have been thirty-two students, and all have experienced the thrill of flying with an instructor. The training includes a rigid inspection of the plane after each flight. In this way the pupils become thoroughly familiar with all the mechanism.

A recent remarkable achievement of the Galt school students was the assembling of a seven-passenger Fokker-type Martin observation plane, which the boys changed to a single-control of passenger type.

On completion of the high school flying course, each student will be eligible to become a cadet flyer in either Army or Navy.

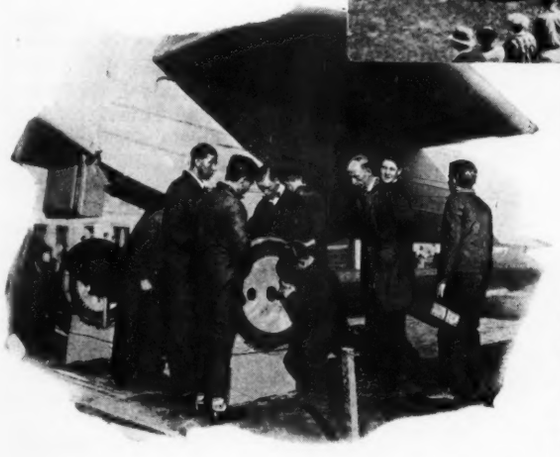


Actual class scene at Galt Joint Union High School, Galt, Calif.,—students checking their plane, *Spirit of Galt Hi*, after a flight

Popular Science Monthly was one of the first to tell how to build model airplanes. From month to month we have published designs and blueprints of flying models. Our latest is a two-propeller "pusher" model described on page 82 of this issue.—The Editor.

Another California high school recently purchased from the Government a $35,000 Martin observation plane. It was partly assembled at Rockwell flying field, then towed to the school campus, where the schoolboys completed the assembly, supervised by instructors, Lieut. L. T. Kittredge and J. G. Dickson.

Dedication meet of the Los Angeles Junior Airport. Note the marked-off runways. Left: San Diego, Calif., high school boys begin to dismantle the observation plane obtained from the Government



In this school actual flying is prohibited. The plane is used entirely for "ground work." Already the young mechanics have dismantled the 200-horsepower Hispano motor, learning the secrets of its operation, part by part. It is expected that actual flying soon will be included in an advanced course.

The experiences of these schools give an indication of what may be expected in other cities if the plans of the Guggenheim Fund are carried through. Courses in aeronautics already have been established in California Institute of Technology, Massachusetts Institute of Technology, Leland Stanford, Jr., University, the University of Michigan, and New York University. To extend the plan to elementary and secondary schools, a committee of eighty leading educators, headed by Dean John H. Withers of New York University, is coöperating with school superintendents throughout the country.

LAST year, under the supervision of the Playground and Recreation Association of America, more than 20,000 boys and girls entered miniature airplanes of their own making in endurance contests in more than 100 cities. The winners qualified in a big national finals meet which was held in Memphis, Tenn., last October. Some of the competing ships were copied exactly to scale from real planes; others were of original design.

The record flight was made by a little thirty-nine-inch monoplane with twin propellers, built and launched by a twelve-year-old Chicago boy, Jack Lefker. It stayed in the air five minutes and thirty-seven seconds!

This year the youngsters are keener than ever for the new sport and two national contests are under way. One is a repetition of the national playground tournament, directed by Orville Wright, chairman, and Col. Charles A. Lindbergh, associate chairman. Commander Richard E. Byrd, U.S.N., and Henry Ford are other members of the committee in charge. Bulletins distributed among contestants give detailed instructions for building model aircraft, and in some cities the boys and girls are aided by playground instructors. The national finals will be held October 5 and 6 at Atlantic City, N. J.

Orville Wright, the father of aviation, says:

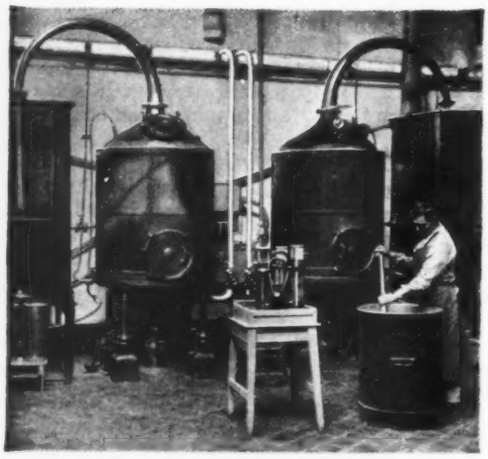
"My first interest in aviation started with a toy flying *(Continued on page 136)*

You might take this for a wholesale pharmaceutical plant, but it is the bottling room of one of the perfume plants at Grasse, French Riviera, the "perfume capital of the world"

Vile Smells Made into Perfumes

The Almost Incredible Story of the Strange Substances Used to Make Rare New Scents

By P. A. CARMICHAEL



Mixing orris root, foundation of violet perfumes, with water. The essence will be distilled by use of the vats. One ton of orris yields two ounces of essence

A NEWS dispatch from Nice, France, tells of the loss of the flower crop in the vicinity of Grasse as a result of frost and snow. Grasse, center of the perfume industry of the world, is surrounded by thousands of acres devoted to violets, roses, carnations, jasmine, hyacinths, lilies-of-the-valley, and other flowers.

A cold snap there is like a blizzard in Florida when the orange trees are in bloom. The loss to Grasse and vicinity is estimated at $2,000,000.

Cold weather could kill all the flowers in the world, however, and still not deprive us of perfumes. We have learned how to get them from sources in no way related to flowers—sources which sometimes are anything but fragrant.

One of chemistry's great new triumphs is the conversion of human perspiration into a flowery fragrance.

Deodorants—long known and used—may destroy offensive odors, but are far from substituting fragrance in their place.

Now, however, the chemists are finding ways to make molecular changes in substances such as perspiration which turn the substances into all manner of things—some foul-smelling, some fragrant and some without any scent at all. It is all a matter of chemical reaction. A chemical agent is applied to the skin—an agent in the form of an unscented or neutral perfume. The body perspires, an interaction sets in, and fragrance results.

Perfumery is now largely a matter of converting materials, such as coal tar, into flowerlike fragrances. So skilled have chemists become that they have lately obtained, in Germany, a product worth several times its weight in gold. This is synthetic musk, worth $300 an ounce. Musk, in the natural state, is anything but pleasant to most people. A product of a little sac in the abdomen of the Oriental musk deer, it is used in perfumes as a fixative, preventing their evaporation, which otherwise occurs very quickly.

Civet, also used as a fixative, has a very offensive odor, which is overcome by extreme dilution. It comes from the African civet cat. Dogs hunting the cat are often overpowered by the scent and flee instead of attacking.

Of the materials used in perfumery, ambergris, also a fixative, is one of the most highly valued, and it is highly unfragrant. It is a product of a fatal disease of whales. Fish eat the whale, but the ambergris is too rank even for them.

The gas phosgene, one of the deadliest, was used on the battlefield with terrific effects. Today it is used in the drawing room after the chemist converts it, as though by magic, into a dainty violet odor.

Gathering roses for use in perfume making. The flowers are mingled with fat, which absorbs their essence. Then alcohol is used to extract the essence from the mixture

(Continued on page 135)

The Wind's Whirligig *of* Death

New Facts About Tornadoes That Explode Houses, Smash Bridges to Bits, and Toss Babies About Unhurt

By L. G. POPE

Technically a hurricane—a windstorm of extreme violence covering an extensive area—the Florida storm of two years ago included at least one tornado, as the photograph below proves. The picture, taken from Hialeah, shows the "finger" of the cloud reaching earthward

Bounding forward with express train speed, the funnel-shaped tornado clouds frequently can be seen approaching over the prairies. Here is a typical cloud, photographed in Oklahoma

IT IS a sultry spring afternoon. The earth holds its breath, as if awaiting some mighty event. Black clouds roll up along the horizon. Scattered at first, they swiftly form in solid phalanx and advance, a grim, menacing host. Thunder crashes like big guns. Lightning streaks the sky. Hailstones rattle like machine gun bullets.

A cloud blacker and angrier than the rest comes rolling and tumbling madly. With an ugly whirl it extends a giant, mile-long arm toward the earth. A strange writhing whip of wind, it lashes its tip here and there along the ground, annihilating whatever it touches.

Trees are stripped of branches and flung high into the air. Houses burst apart like bombshells, strewing roofs and rafters far and wide. Human beings, animals and fowls soar through the air like birds, to be dashed to death perhaps a mile away. A terrible monster passes a peaceful habitation, leaving destruction and death.

That is a tornado, most vicious and terrifying of all storms, exceeding in violence even the dread tropical hurricane. And as the U. S. Weather Bureau recently warned, this is the tornado season—March, April and May. Their playground is the Mississippi Valley; seldom do they visit other parts of the world. Only on rare occasions do they cross the borders of states east of the Allegheny Mountains or west of Denver.

Pranks played by tornadoes were demonstrated at Murphysboro, Ill., where a board was driven into a tree and a saw horse carried into the branches

Every year, on the average, 100 tornadoes visit the United States, most of them in spring and fall. They kill an average of 250 persons a year and cause $8,000,000 damage. Fortunately, these monsters blow their deadly breath over prairies and farm lands where homes are scattered, and the damage is comparatively slight. But about twice in a decade densely populated cities and towns chance to lie in their path.

In March, 1925, a swath of destruction 200 miles long was cut through Missouri, Illinois, Indiana, Kentucky and Tennessee, wrecking thirty-six towns, killing more than 800 people, injuring nearly 3000 and damaging property to the extent of $18,000,000.

IT STARTED in the Ozark hills of Missouri and, sweeping northeastward with express train speed, unloaded its full fury in southern Illinois and Indiana. Fire, following in its wake, added to the horror.

Exactly what causes the "twisters" of wind and their amazing pranks is a riddle that long baffled scientists. According to the latest theory, explained by Dr. William J. Humphreys, professor of meteorological physics, of the U. S. Weather Bureau, they spring from the clashing of two great streams of air. On one hand are cold winds draining southward from Canada and deflected by the Rocky Mountains toward the Gulf of Mexico. Opposed to them are warm, humid trade winds from the Gulf, proceeding northward. Where the two meet, they join in a mad whirligig of death, a mile up in the sky. From a spinning cloud the commotion beats downward to earth in a long funnel-like arm, a mighty whirlpool in an ocean of air. At the center of the funnel is a partial vacuum produced by the centrifugal force of rotation.

This vacuum is responsible for the strangest whim of the tornado—the explosion of buildings in its path. As the

vortex of the whirl passes, the pressure of air outside the walls of a building suddenly is reduced to almost zero. But the air inside the building is at normal atmospheric pressure. In its rush to escape it acts like exploding dynamite, bursting the walls and shattering windows. By the same process tornadoes have been known to uncork empty bottles and split empty kegs wide open.

During the five-minute tornado which wrecked hundreds of buildings in St. Louis last September, an automobile mechanic, looking through his garage window, saw the walls of a baker's shop across the street split wide open and tumble outward. A three-year-old baby girl sailed out through one of the cracks. Riding the wind, she soared high over the street, to be deposited, unharmed, in a vacant lot several blocks away. Meanwhile the garage and the astounded witness both remained unscathed.

MOST of the "freak" happenings which once led people to regard tornadoes with superstitious awe now are known to be caused by the terrific velocity of the rotating air. No one ever has measured this velocity, for no one has devised measuring instruments capable of escaping destruction in such storms.

Estimates of the speed, however, range from 500 to 1,000 miles an hour. Even the lower figure is at least four times the velocity of most of the winds reported in the tropical hurricane which devastated parts of Florida two years ago.

The forces let loose in a "twister" are titanic almost beyond belief. The wind has been known to drive one wooden beam straight through another, to lift heavy steel bridges from their foundations, to roll boulders weighing many tons along the ground, to pull bricks out of the walls of buildings. Chickens have been stripped of their feathers and people of their clothing. Straws have been driven into tree trunks. In the recent St. Louis storm a freight train was hurled from its tracks; automobiles were flung through plate glass windows. There is recorded one tornado in which a horse flew two miles through the air.

In Princeton, Ill., four men were lifted from their motor car and deposited unhurt at the roadside. The machine was carried across a field and wrecked. A large grain elevator was carried intact to the middle of a road forty feet away. When the wind had passed, 1,500 persons found themselves homeless.

AT Murphysboro, Ill., 100 business and residential blocks were razed and eleven locomotives were wrecked.

In many cases, the crushed bodies of victims were found pierced with wind-driven sand, pebbles, and splinters.

A freakish prank common to most tornadoes is that the destroying tip skips on its course, rising at intervals to descend again farther on. Frequently houses have been blown to bits while their neighbors have stood almost unharmed. Sometimes intervals of many miles separate the places of damage. A particularly destructive tornado which hit East St. Louis in 1896 was hung suspended thirty feet above the ground much of the time, so that it demolished only the tops of many buildings.

Although the Southwest and the Mississippi Valley are called the playgrounds of tornadoes, other regions are not immune. This photograph of a funnel-shaped cloud was taken at Alberta, Canada

WITNESSES say it seemed to single out certain buildings for especial vengeance. In one instance it carried away a team of horses, leaving a wagon-load of bricks untouched.

Almost everyone who has lived through a tornado tells of its frightful roar. A former Army chaplain said that the tornado at De Soto, Ill., sounded like nothing so much as the war zone in France. And a locomotive engineer described the tornado as "a crash of thunder preceded by two blinding flashes of lightning, after which there was nothing left."

Most of the fearful uproar, meteorologists say, is undoubtedly the bellowing of the wind, swelled by the crashing of trees and buildings.

Tornadoes in the United States invariably rotate in a counter-clockwise direction—a fact which apparently bears a direct relation to the rotation of the earth. The storms move across the country at speeds of thirty to seventy-five miles an hour. Almost always they travel from southwest to northeast. Over the prairies the approach of a tornado may be seen at such a distance that people have time to flee or to seek refuge in "cyclone cellars." Every community in the tornado belt has these caves of refuge.

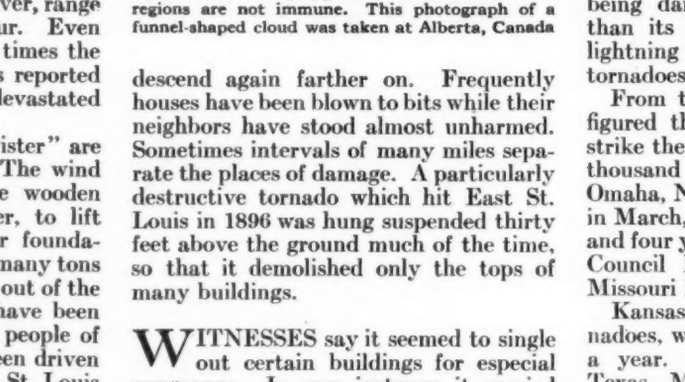
SINCE tornadoes are almost always local disturbances, seldom damaging an area larger than a quarter of a mile wide and twenty miles long, the chance that you will be caught in one is quite remote. Weather Bureau statistics show that the likelihood of any certain building being damaged by a "twister" is less than its chance of being destroyed by lightning or fire, even in regions where tornadoes are most frequent.

From the laws of chance it has been figured that a tornado is not likely to strike the same spot more than once in a thousand years. Still, one locality in Omaha, Neb., was visited by a "twister" in March, 1913, and again in April, 1919; and four years later a third swept through Council Bluffs, Iowa, just across the Missouri River.

Kansas leads in the frequency of tornadoes, with an average of six and a half a year. Illinois is second with five. Texas, Missouri, Oklahoma, Nebraska, Mississippi, Alabama, Iowa, the Dakotas, Minnesota and Indiana all experience the storms in lesser numbers.

"Twisters" do occasionally visit the eastern seaboard in comparatively mild form. In twenty-five years Pennsylvania has experienced more than forty, New York State more than thirty, and Massachusetts ten. Only a few months ago one caused large damage in Washington, D. C. And two summers ago, only thirty miles from New York City, a funnel cloud appeared over Long Island Sound in the form of a water spout, which played havoc with homes on the shore.

Should a tornado ever hurl itself upon a densely crowded city like New York or Chicago, experts say, buildings like the Woolworth tower might not be blown over, yet their walls of masonry might be blasted away from their steel skeletons.



Just on the edge of a tornado in Florida. This area escaped, but from the palm trees one may imagine the force of wind at the tip of the funnel

New World Air Trails Blazed

Records Repeatedly Smashed by Costes, Lebrix and Hinkler between Europe and Africa, South America, Australia

By
HYATT E. GIBSON

Lieut. Joseph Lebrix (left) and Capt. Dieudonne Costes, French blazers of air trail to South America, who made the world's longest water hop, 2,100 miles from St. Louis de Senegal, Africa, to Port Natal, on Brazilian Coast

THREE heroes of the wing are responsible for new air lines that are already being planned to link Europe and South America, England and Australia. Two of the trail blazers, the French flyers Capt. Dieudonne Costes and Lieut. Joseph Lebrix, recently passed through New York, 22,850 miles out of Paris, on their epochal flight around the world. The other, the young Australian pilot Bert Hinkler, has just arrived at Bunderberg, Australia, after the greatest solo flight in aviation history.

"A flight solely to demonstrate, beyond question, the safety and reliability of aviation!" Thus Capt. Costes, in a statement to POPULAR SCIENCE MONTHLY, epitomized the longest water jump of any successful trans-Atlantic flight—a 2,100-mile leap that even surpassed Lindbergh's. It followed a bee line 2,900-mile dash from Paris to St. Louis de Senegal, in Africa, the point of the hop-off.

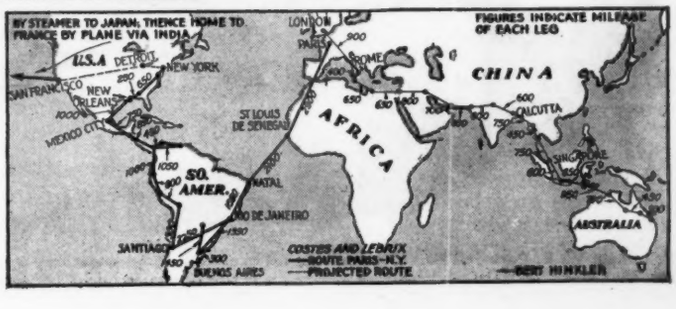
Below the Frenchmen in their green Breguet plane rolled the Atlantic's foam-crested waves, waiting to swallow them as they had the flyers' countrymen, the brave St. Roman and his comrades. When they grew hungry, Costes said, they munched sandwiches, Lindbergh style. It was dark now, as they roared on. Lights ahead. The mainland! Swooping down out of the night sky, they landed on the unfamiliar field at Port Natal, Brazil, acclaimed the first men ever to span the South Atlantic in a single hop.

TEN days after starting, they had reached Buenos Aires, Argentina, and delivered mail and packages from Paris, nearly 8,000 miles away. In the tour of South America that followed, they made a perilous night crossing of the Andes, nearly four miles high, to reach Santiago, Chile; and again landed at the city that boosts the world's highest airport—La Paz, Bolivia, whose flying field is 13,000 feet above sea level. Via Central America and Mexico they came to the United States to continue their trip, with its customary clocklike adherence to schedule, to San Francisco, where a ship was to carry them and their plane to Japan.

"From there," Costes said, "we shall fly back to France by way of India." Their return home will heap them with coveted awards. France is proud of the two war veterans and of the honors they have brought French aviation.

Another sort of trip has brought fame to Hinkler, who simply flew home! He covered 11,900 miles—the longest solo flight in history—to see his widowed mother in his home town of Bundaberg, Australia. In carrying out his promise to visit her, made two years ago, he captured four other records as well. He lowered to fifteen days the former twenty-seven-day record flight time from England to Australia; he had made the first nonstop flight from England to Rome, and the fastest to India; and had completed the longest flight ever made in a light plane.

Bert Hinkler, who in his trip from England to Australia to visit his mother in his birthplace made the longest solo flight on record, cut twelve days from the previous record between the two countries and broke three other records. At right: Map of Hinkler's historic flight and that of Costes and Lebrix, intrepid French aviators



Gives 42 Quarts of Blood To Save 86 Lives

By George Lee Dowd, Jr.

Thomas Kane, ferry deckhand, at the work which he resumes after undergoing a blood transfusion. He has given seven times the entire quantity in his body

WHITE-CLAD nurses flitted about a quiet room in Bellevue Hospital, New York City. A doctor held a feeble wrist. It belonged to a woman—so young that as she lay there, half-buried in the covers, she seemed scarcely more than a child.

It was New Year's eve. Would this young mother live to see the new year? The doctor's face was grave. "Her whole system's poisoned," he muttered to a nurse. "Only a pint of the best blood there is can save her."

Another doctor entered, spoke quickly to him. "All right, I'll see him." He strode into the anteroom, where a short stocky man with a ruddy face was waiting.

"My name is Kane—Thomas Kane," said the short man.

"You answered our emergency call for a blood transfusion?"

"Yes, for this Stewart case."

A FEW minutes later, the girl lay on an operating table. Already, it seemed, color was returning to her pale cheeks. On the adjoining table they were dressing Kane's arm.

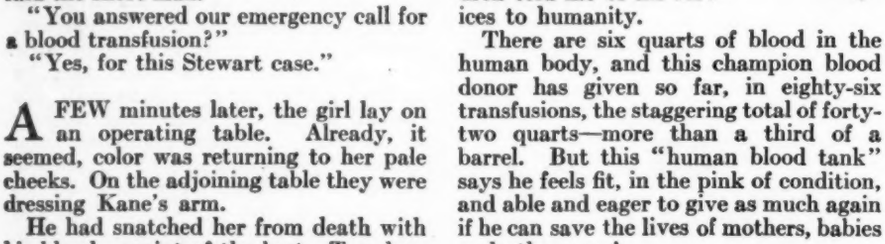
He had snatched her from death with his blood—a pint of the best. Ten days later saw the sick woman sitting up, well on the road to recovery.

So it was that I met Kane, to whom such a dramatic episode is but an incident in an extraordinary career. He probably has given more of his blood to save others than any other man in this country, if not in the world. His arms are covered with scars of the surgeon's knife, and he has difficulty keeping track of the number of operations he has undergone.

I wanted to hear from this man's own lips the story of his amazing experiences. All day, I found, he is deckhand at a ferry dock. He was hoisting a huge plank to a ferryboat under repairs when I came upon him—a sturdy man of forty-one. While smoke curled from his briar pipe this father of three children told me of his services to humanity.

There are six quarts of blood in the human body, and this champion blood donor has given so far, in eighty-six transfusions, the staggering total of forty-two quarts—more than a third of a barrel. But this "human blood tank" says he feels fit, in the pink of condition, and able and eager to give as much again if he can save the lives of mothers, babies and other men!

Thousands of "professional blood donors," like Kane, are always within call. Through the miracle of modern surgery, they can give pints and quarts of their blood to aid sufferers from anemia, pneumonia, blood poisoning, typhoid fever, and a host of other dread diseases. With new blood in his veins, the patient has a far better chance to fight his malady.



Policeman W. F. Parks, of Brooklyn, making his twentieth blood donation—a pint in an effort to save his son. The miracles of modern surgery have made this operation one of the most valuable to mankind

But it must be the right sort of blood—not only of high quality, but of a kind to match the patient's! There are four distinct types of blood, and if the wrong type is used a patient may die. A mother's blood may differ in type from that of her child and a brother's from that of a sister. That is why all professional blood donors are tested, or "typed up," at hospital laboratories, and their blood sample kept on file. As an additional safety measure, their blood is examined just before each transfusion. Kane, for instance, is a "Type 2"; and samples of his blood are filed throughout New York City and suburbs.

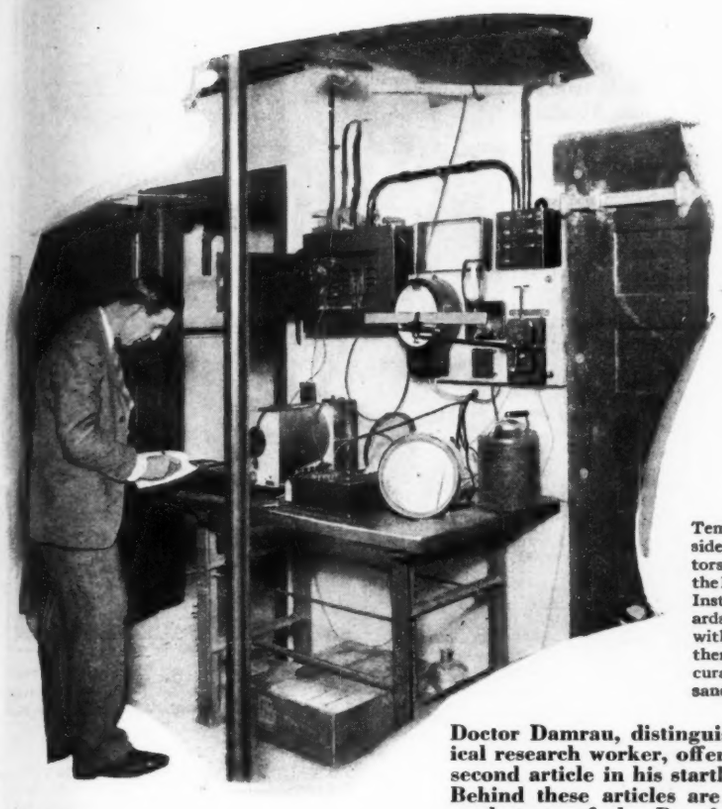
A few weeks ago a great lawyer lay dying in the State Hospital at Poughkeepsie, N. Y. Sleeping sickness had gnawed his body to the point of death. A hurry call to New York brought Kane. A few hours later his blood was drained into the veins of the lawyer. In less than two weeks the patient was on his feet, a well man!

THESE are not miracles. The secret is that Kane's blood is of extraordinarily high quality; high in the "Wassermann test" by which physicians gage the value of blood. But Kane has given as much as three pints in ten days, and continued at his hard daily work. He feels no after effects; his pulse and respiration are normal, and his face does not pale as do those of virtually all other blood donors. A group of doctors at the Post Graduate Hospital in New York ascribed his remarkable power simply to his regular habits and his healthy, outdoor life—plus his natural splendid physique. One of them told me that if Kane's molars *(Continued on page 134)*

When Iceboxes Breed Germs

The Indisputable Evidence That the Many Millions of Refrigerators Which Allow Temperatures to Rise Over 50 Degrees and Even to 68 Allow Food to Spoil and Are Incubators of Disease

By
FREDERIC DAMRAU, M.D.



Temperatures inside the refrigerators under test at the Popular Science Institute of Standards are checked with an electric thermometer accurate to a thousandth of a degree

Doctor Damrau, distinguished medical research worker, offers here the second article in his startling series. Behind these articles are the thorough tests of the Popular Science Institute of Standards and months of study of household refrigeration as it affects the family health. The facts he presents are of vital interest to every reader.

FOOD in storage and in transportation is safeguarded with adequate refrigeration. Rigidly enforced laws insure temperatures low enough to prevent food spoilage. But the care which food receives after reaching the family icebox has been left largely to chance. The result is a menace to health.

Take milk, the principal nourishment for babies and small children, as an example. Without adequate refrigeration, milk deteriorates more rapidly than any other important food. It must be kept at a temperature of not more than 50° on the standard Fahrenheit scale if dangerous multiplication of bacteria is to be prevented. At this point germs begin to multiply with great rapidity; a temperature of 45° offers real safety.

At higher temperatures bacteria in milk multiply so rapidly as to make it unwholesome and sometimes even poisonous. And a refrigerator maintaining higher temperatures may be a good disease incubator.

Certified milk, produced under the supervision of physicians, and available in many cities, is unquestionably the safest that can be obtained. Tests made during the week ended February 18, 1928, in Brooklyn, New York, showed that certified milk kept in a refrigerator maintaining a temperature of 42° can be kept wholesome for twenty-four or even forty-eight hours.

But in the same grade of milk placed in a refrigerator maintaining a temperature of 55°, the bacteria multiplied six times in twenty-four hours and one thousand times in forty-eight hours. Kept at 60°, the multiplication was sixty times in twenty-four hours and nine thousand times in forty-eight hours. At 68° it was 150 times in twenty-four hours and more than 150,000 times in forty-eight hours!

Bacteria in milk are counted by mixing it with sterile water, after which exact amounts of the diluted milk are poured into tubes of melted agar of gelatin. The contents are then poured out on glass plates and placed in an incubator for two days. Each microbe develops a tiny colony of bacteria, which can be seen on the agar or gelatin plate. By counting the number of colonies and the use of exact scientific data we can determine the number of germs present in any given sample of milk.

The number of bacteria in milk is the best index of its general sanitary condition. "Milk containing more than 10,000 bacteria in each fifteen drops becomes a menace to infants' health; and the higher the count, the greater the menace." That statement was made to me by Dr. Alec N. Thomson, Secretary of the Milk Commission of Kings County, New York, one of the greatest authorities on milk as it affects our health.

MANY persons, some of whom occupy high official positions, retort that the millions of bacteria multiplying in milk kept in poor refrigerators are "harmless." Of course, some microbes are innocent or even beneficial to health. These are the bacteria used in making cheeses and those that form lactic acid in milk. But it is unfair to assume that the microbes to which we have attached the names of serious diseases—such as typhoid and tuberculosis—are the only harmful germs found in milk. The facts are that, when it comes to the delicate health of a baby, millions and millions of *miscellaneous* microbes in milk can never be entirely harmless.

Milk kept for twenty-four hours or longer in a poor refrigerator is full of *miscellaneous* bacteria. In fact, they are so numerous that, if the milk were transparent, we should not be able to see through it because of the dense clouds of germs. Most of these microbes are harmless, but some are not.

When Is an Icebox a Refrigerator?

Next month Dr. Damrau will present facts important to everyone interested in effective household refrigeration.

A list of refrigerators, tested and approved as safe for family use by the Popular Science Institute of Standards, may be had for the asking. A booklet advising how to choose and care for a refrigerator, "Refrigeration for the Home," will be sent for 25 cents. Address Popular Science Institute of Standards, 250 Fourth Avenue, New York City.

While we do not know the exact proportions of good and bad, we know that such milk is unfit for a baby's stomach. Even dead bacteria may be injurious if present in sufficient numbers. An injection of typhoid vaccine, consisting of killed typhoid bacilli, may produce fever and considerable discomfort for a day or two.

How milk containing large numbers of bacteria may cause serious illness in babies was illustrated in Baltimore in the summer of 1922, when 284 babies died from summer complaint—fifty-eight percent more than the average number of infant deaths from this condition in other American cities.

Drs. J. H. Shrader and J. C. Swenarton, officials of the Baltimore City Health Department, showed that the death rate from summer complaint ran parallel with the bacterial count in the milk supplied in the city. When the number of microbes in the milk rose, the death rate from this disease was correspondingly higher, and this despite the pasteurization of the milk, the bacteria killed by this process causing harm by their tremendous numbers.

YET, as I pointed out in my article last month, in nine out of ten families the equipment for preserving food is a disgrace to the family and a menace to its health. In nearly fourteen million homes there is no refrigerator whatever. People actually court disease by keeping food in cellars or on window sills. In as many more the iceboxes are leaky, have their bottoms out or their doors sagging. In others boxes of poor design or manufacture invite microbe multiplication. And too often the box is kept, with disastrous results, in a sunny corner or near a stove.

In coöperation with the engineers of the Popular Science Institute of Standards and the editors of POPULAR SCIENCE MONTHLY, I have been studying these conditions for months. Investigations, extending into every state in the Union, reveal that most people not only are unconscious of the very real dangers to their health in such boxes, but also are ignorant that such boxes run up uselessly high ice bills.

These investigations show conclusively, too, that nothing is farther from the truth than the all too general idea that a cool pantry or a window ledge offers a safe and practical way to preserve food. Even a poor icebox is better than no icebox. But without a properly built refrigerator no family can be sure that its food is free from the lurking danger of disease.

Every householder owes it to his family to see that he has an effective refrigerator. And an effective box is more than nice white lining and polished hinges and handles. It is a refrigerator that is properly built and insulated with something more than fresh air. It is a box with an ice chamber occupying twenty-five to thirty-five percent of the total cubic capacity of the box. And it is a refrigerator which in actual conditions of use will maintain a temperature of not more than 50° Fahrenheit.

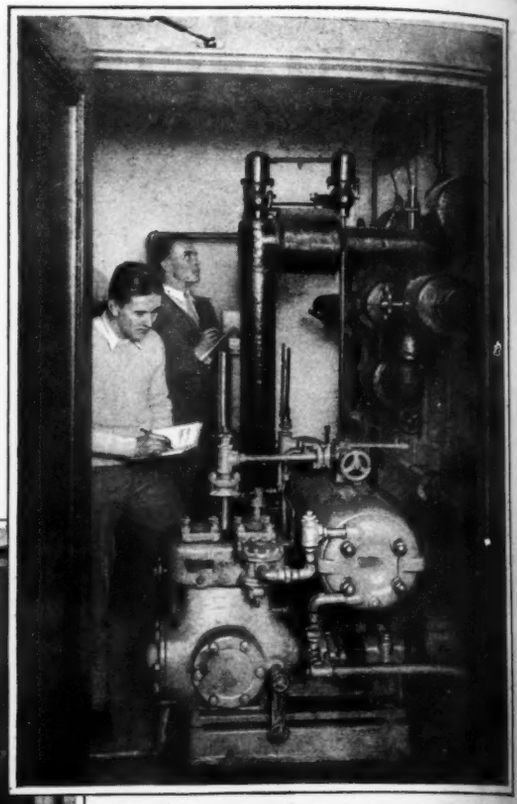
What is true of milk is true of meat and other foods. Meat may be kept in cold storage for many months and still remain wholesome. A few years ago the carcass of an extinct species of mammoth, discovered in northern Siberia, covered with ice and snow, was in excellent state of preservation although thousands of years old. Wolves and

Examining an icebox under test in the constant temperature room. Here guessing is eliminated. Performance determines a refrigerator's worth

underfed natives of the region started to eat the flesh. Part of this animal is now in the Soviet Museum at Leningrad.

But meat kept at a temperature above 50° soon decays. Tests by Jean Broadhurst and Mary B. Van Arsdale, of Columbia University, showed an actual decrease in the bacterial count of meat kept in a refrigerator at a temperature of from 40° to 45°. Kept in an icebox whose temperature rose as high as 60°, the number of bacteria within forty-eight hours was increased 130 times.

Chemical changes, too, may take place in meat or other food allowed to spoil by reason of improper refrigeration. Various ptomaines, some poisonous and some not, are formed. These substances must not be confused with the condition improperly called "ptomaine poisoning," which is the result of eating meat previously



The machine that keeps the temperature constant at any desired degree in the refrigerator testing room of the Popular Science Institute of Standards

infected rather than that which has been allowed to spoil.

Just as in the case of milk, bacteria multiply rapidly in other foods when kept in a refrigerator which fails to maintain a temperature below 50°. Bacteria in meat broth remaining for forty-eight hours in an icebox at a temperature of from 60° to 65° multiply more than 5,000 times. And the food may taste good in spite of the fact that it is teeming with microbes! Jean Broadhurst and Mary B. Van Arsdale gave five persons samples of veal soup in which bacteria had multiplied 1,420 times, and all pronounced it palatable. A similar result was obtained in the case of chicken soup in which bacteria had multiplied 1,400 times, and in raspberry gelatin in which the increase was ninety times.

SO IT is that inefficient refrigeration may be poisoning you slowly, even without your realizing it. An ordinary household thermometer placed in the icebox will tell the story. If, after being kept there thirty minutes, it shows a temperature anywhere in the food chamber of more than 50° Fahrenheit, the refrigerator is inadequate. For real safety a temperature of not more than 45° should be maintained in the milk compartments of side icing boxes and mechanical refrigerators and on the top shelves of top icing boxes.

Next month—"I Can Look into Your Stomach and read Your Future," one of the most fascinating and important health articles ever published. A leading American physician tells of amazing advances in the use of X-rays, and reveals how diseases, once mysterious, give up their secrets to this all-seeing eye of medical science.

Railroad Yards to Be Airports Too

AIRPORTS on stilts may provide landing spots for airplanes in the very hearts of cities one of these days, according to Postmaster General Harry S. New. Already, he says, several railroads are considering the ingenious plan of erecting roofs over their tracks at the terminals to turn the only existing waste space in cities into airplane landing fields.

Our artist pictures, above, his conception of this plan which the Postmaster General endorses. "If a landing field may be arranged on the deck of a ship," says Mr. New, "may it not be equally possible at railway terminals?"

To an airman, flying over a great city, the plan seems eminently practicable. He sees a jumble of buildings, a mass of jagged skyscrapers and, running between them, a ribbon of tracks that would, if roofed over, make an ideal landing field. Moreover, the terminals of railroads are necessarily so chosen as to be within quick and easy access to all parts of a great city. No longer would an airman have to ground his plane at a port far removed from his final destination; he would land within five minutes of it.

AT THE Bush Terminal in Brooklyn, N. Y.; at Washington, D. C., with its great expanse of tracks adjacent to the depot; over the tracks of the New York Central Railroad as they run north and south through the heart of New York; above Chicago's railroad yards, and in other great cities, Postmaster General New sees the new type of landing field bringing speedy aerial transportation of mail, passengers, and freight.

"The whole upper deck," he says, describing such a landing field, "is without an obstacle all the way across its smooth surface to interfere with the landing and the taking off of planes." It might be possible, too, to have additional stories, in which case the roof would serve as landing field and planes would descend by huge elevators to housing space on a lower level.

Though various inventors have described such railroad landing fields—a ribbed, iron-floored platform above the tracks was one of the features of such a recent scheme—Postmaster General New's statement gives the important impetus of official sanction to the novel idea. With seven new air mail lines contracted for, which will add seven thousand miles a day to the 17,444 now covered by postal planes, provision for increased landing facilities is vital.

"IN THE case of air mail," New says, "it is necessary to get it to the post office without the sacrifice of a minute." And the growth of commercial aviation, too, he adds, depends directly upon the provision of adequate airports with quick accessibility to cities. All these problems the railway landing field would solve.

Puzzlers Meet *in* War *of* Wits

"C. Saw," with his gavel, gives the starting signal for America's leading puzzle experts to begin work on an intricate brain teaser

See if You Can Solve the Strange Brain Tests That Challenged the World's Leading Experts

By ALDEN P. ARMAGNAC

I HAVE just come from the strangest convention ever held—that of the National Puzzlers' League. In a great Philadelphia hotel room lawyers, doctors, engineers, judges and school teachers sat in rows about tables and wrestled with the most intricate puzzles I have ever seen. There were spectators, too—who watched over the shoulders of the puzzle-solving competitors, or gathered in little groups to tell of their own latest creations. They called each other by odd, fanciful names as far removed from their real ones as their hobby from their businesses.

One they called "R. Thur," who is really Arthur Hirschberg, a teacher of science in a New York high school, was telling of the following puzzle recently presented to the grave scientists of the British Royal Society:

"Two cyclists, ten miles apart, pedal toward each other at speeds of five miles an hour. Meanwhile a fly, winging at fifteen miles an hour, speeds from one to the other and back again repeatedly as they approach. How far has the fly traveled before the two cyclists meet?"

"That looks like a tough one," a puzzler said. "That's why it's tricky," R. Thur agreed. "An engineer tackled it by the formidable process that mathematicians call the 'method of least squares'. He announced his answer, after hours of work with a slide rule, '14.9999 . . . miles.' He was heartbroken when they pointed out to him that he had wasted his time. See why?"

"Wait a minute—I think I see. The cyclists must meet in just one hour."

"Yes."

"And the fly is going at fifteen miles an hour."

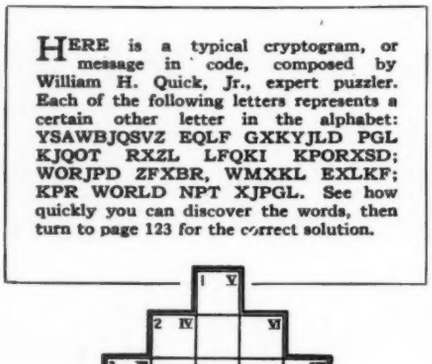
"You have it. The answer's exactly fifteen miles, of course. It doesn't matter whether the fly went from cyclist to cyclist or took a side trip to the seashore. If our engineer had been quicker-witted he would instantly have got the exact answer instead of his approximation."

The men and women in that room, I found, were the most expert puzzle makers in this country, if not in the world. Some of them devise puzzles for daily papers and other periodicals, but most of them create brain-teasers purely for the joy of it, as their hobby.

And they represented almost every business and social stratum. There was "Poor Richard," as John Pritchard, of Audubon, N. J., calls himself—youngest of the puzzlers, a boy of thirteen, and a genius at solving cryptograms, they say. "Uncle Nat," probably the oldest of them, is Nathaniel Lang, of Warren, O., a court bailiff of ninety-two years.

At this get-together of the leading brains of puzzledom, "Rho Mu Mu," a stately gray-haired woman, and "Jazetta," an enthusiastic young puzzler in her teens, helped defend their sex. Husbands and wives were there together. The "Duke of Gloucester" and the "Duchess"—Mr. and Mrs. W. E. Klosterman, of Philadelphia; "Gigantic" and "Petite"—Dr. and Mrs. A. F. Kleykamp, of St. Louis, Mo.; "Vesalius" and "Vesalia,"—Dr. and Mrs. J. E. Nowrey, of Camden, N. J., and "Lateo" and "Latea," who are Dr. and Mrs. J. E. C. Snyder, of Hoboken, N. J.—these were among the *(Continued on page 122)*

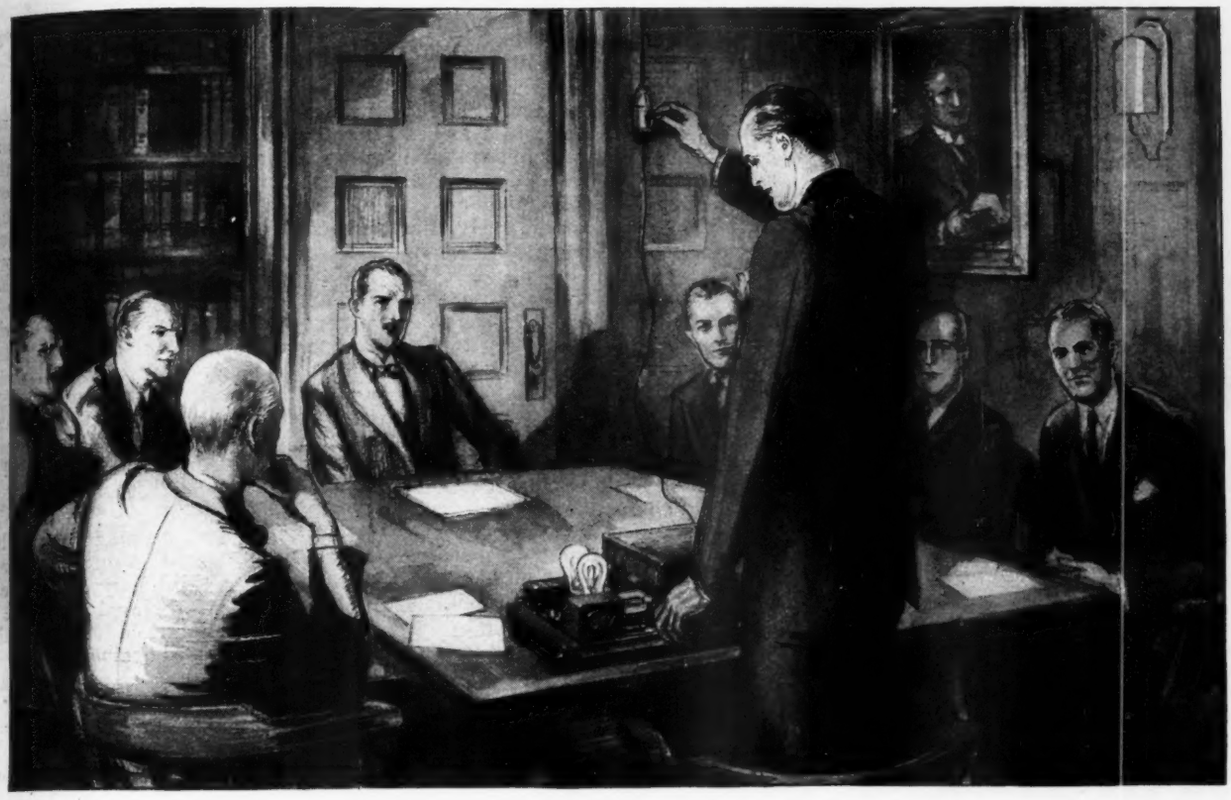
HERE is a typical cryptogram, or message in code, composed by William H. Quick, Jr., expert puzzler. Each of the following letters represents a certain other letter in the alphabet: YSAWBJQSVZ EQLF GXKYJLD PGL KJQOT RXZL LFQKI KPORXSD; WORJPD ZFXBR, WMXKL EXLKF; KPR WORLD NPT XJPGL. See how quickly you can discover the words, then turn to page 123 for the correct solution.



IF YOU succeed in solving the ingenious word form above, you will have a diamond of letters that spell the same words across and down. The definitions of the words (across, 1, 2, etc.; down, I, II, etc.) are:

1, I	A letter
2, II	Addressed to
3, III	Chased into a burrow
4, IV	An erect lock of hair once fashionably worn
5, V	Of slightly more than atomic dimensions
6, VI	Readjusted to correct musical pitch
7, VII	Metes out in small quantities
8, VIII	A bound sheaf of papers
9, IX	A letter

The correct solution appears on page 123.



With his lawyer beside him, the inventor demonstrates his device to a manufacturing company

Pitfalls *That* Await Inventors

Many a Man Gets Nothing for a Splendid Idea and Years of Labor—Here Is the Way the Wise Man Avoids That Fate

By Bruce Donald

YOU have patented an invention. Let us assume for the moment that you have a patent that is valid, so far as search through the patent records can disclose—though, as I endeavored to show in last November's Popular Science Monthly, that is often in doubt. Now you are ready either to develop the patent yourself or to turn it over to some organization to develop. Which will you do?

The inventor who sets out to develop and market his own idea is facing a tremendous task. He must have plenty of money—an adequate source of income while he is perfecting his device. He must be able to employ help. He must possess, too, business ability and vision.

Against all this, one fact stands out. Forty-six percent of all the corporations in the country, according to the National Industrial Conference, failed to make any money in 1925, the last year for which figures are available. Most of them will have to find something that they can sell at a profit, or they will go out of business. All an inventor has got to do today is to find one of these firms. Ten to one, his idea will be welcomed with open arms. Let us compare the two ways.

A friend of mine attempted to market a signal attachment for automobiles. He set aside $20,000 for the cost of marketing. But model after model proved unsatisfactory, with costs mounting all the time. After a year's work my friend took his completed signal to Detroit to demonstrate it to auto manufacturers. It cost too much, they said. If certain changes were made—changes that were well-nigh impossible—they *might* consider adopting it as standard equipment. To date my friend has spent $30,000, yet not a signal has been manufactured!

Perhaps, you may say, experienced engineers would have foreseen and avoided my friend's difficulties. But sometimes it is impossible to foresee. Not long ago I produced an artificial milk that looked and tasted like the real thing. It had all the food value of real milk. I arranged to demonstrate it to an interested firm.

On a stove in the directors' room they had a pot of coffee—the hottest I had ever seen. I poured a cup and triumphantly poured in my concoction. It curdled like sour milk! I had never tried it in such hot liquid. I had found a vital defect, more apparent to me than to the directors who later saw me give a successful demonstration when the coffee had cooled a little. They never knew why I refused their contract and never went back. Actually I returned to my laboratory and tried a thousand times, without success, to make noncurdling artificial milk. Meanwhile another firm came out with a similar product—and was financially wrecked by the same difficulty.

Marketing a new device, or product, is a hazardous business, as cases like these prove. The better plan is to turn the patent over to some organization on a royalty basis. Of course it is sometimes worth

Thought, study, labor, perhaps sacrifice and self denial at last bring forth the inventor's device. What will be his reward? That depends on the wisdom with which he proceeds in his efforts to have it made and sold

while to develop one's idea far enough to demonstrate its value; then he is in a better position to dicker with commercial interests.

Since they have their own established sales and distributing organizations, firms are far better able than individuals to "put over" a new idea. Not long ago an inventor devised a new automobile self-starter, worked by a push button on the dashboard through an electric relay. He took it to a well-known maker of auto windshield wipers, whose wiper patent was about to expire.

Soon the manufacturer would be in open competition, and his profits would dwindle unless he could find a new patented device to keep his three-million-dollar plant busy. Six weeks after he had bought the patent rights, he had orders for 50,000 of the new starters—the result of a sales letter to the 3600 service stations on his list. Compare the royalties from such a commercial exploitation with the doubtful returns the inventor might have gained had he attempted to market his own device!

HOW should one go about finding such a firm? Pick out a number of concerns that make and market products that are in a general way like your own; in other words, firms equipped to manufacture your device. Write to them briefly that you have a patent which you would like to turn over to a manufacturing and sales organization on a royalty or any other basis you may choose. Of this I shall say more shortly.

State concisely, in one-two-three form, just what you have to offer, the patent serial number, the prospective market, and any authorities who have passed on the idea. All data must be precisely correct.

It is a good plan to have an expert letter writer compose this note. If possible, it should come from a brokerage house you have selected to handle your patent, as it will then carry more authority. Naturally the firm gets its first impression of you and your idea from the letter; and many firms get quantities of letters concerning ideas and patents that are absolutely worthless.

Your replies will soon come in. When I recently sent such a letter to six firms, two replied "not equipped to make it," three said they weren't interested but suggested three others, and the remaining firm gave me five more names to try. Soon a writer replied that my idea looked good to him, and he would be pleased to enter into correspondence with a view toward business relations.

At the first favorable reply, the inventor should arrange to demonstrate his patent to executives of the firm. That is all. *Under no consideration should he attempt to close the contract himself.* That is up to the brokers handling the patent, and to the patent attorney who obtained the original patent.

The average inventor, particularly when it is his first experience, either demands an absurd sum which kills the whole transaction or is so anxious to close the deal that he overlooks details of great future consequence. It is important to point out here just what goes into a patent contract.

First you must decide whether to sell the patent outright—or license the firm to make and sell your product. The usual and best way is to grant a license on a royalty basis. Most firms prefer this method, as it cuts their initial expense. So does the inventor. If he sells his envention outright, he is through as far as possible future profits are concerned. Therefore if he has faith in his invention (and most inventors have a superabundance of faith) he will specify a royalty.

SUPPOSE the inventor has decided to grant one firm an exclusive license to make his device (most responsible firms demand exclusive rights for the life of the patent). He must see to it that his invention is pushed, not permitted to lie undeveloped. One clause should call for the payment of a fixed and substantial advance royalty. Then the firm must start manufacture to recover its outlay. It cannot afford to "kill" his invention, that is, suppress it, in favor of one of its own patents. Another protection for the inventor is a fixed minimum yearly royalty. Of course the contract should give the inventor the right to audit the company's books at any time he desires.

Now for the scale of royalties—a fixed amount per unit of sales, to be paid quarterly. Ordinarily quite large for the first few thousand articles, it decreases as sales increase, encouraging the manufacturer to sell more goods. It should be figured upon *annual* sales. When I recently licensed a manufacturer to make an article I had patented, my royalty was to range from forty cents each on the first 5000 to ten cents each on all sales exceeding 50,000. I had neglected to stipulate figuring royalty on an *annual* basis; and when the sales reached 50,000 my royalty automatically shrank to ten cents from that time on! Had I inserted that little word "annual," I would have received forty cents apiece on the first 5000 *each year*.

In no circumstances should the contract fail to include a clause that the manufacturer accepts the patent as valid, and that he undertakes to defend it, at his own expense, against any lawsuits for infringements. When the manufacturer hems and haws over this clause, as he probably will, and even threatens to abandon the whole idea, stick by your guns. He'll give in. Otherwise it's better not to try to develop the patent at all. As soon as a patent becomes commercially valuable, lawsuits aiming to have it declared nonvalid, in order to throw the device into open competition, are bound to arise. They would quickly ruin an individual who tried to fight them.

MORE than once a manufacturer has actually sued himself, through some fictitious third party, to have a profitable patent declared nonvalid in order to free himself from further royalty payments. To guard against this the inventor should insist upon a clause entitling him, should he desire, to be represented at his own expense in any suit brought against the patent's validity.

These are the important clauses, which, with other details, should be found in every patent agreement. *An experienced patent attorney should prepare it.* Then the inventor is ready to proceed with the business transaction.

The broker should take the contract, and the patent, to the manufacturer. *In no case should the inventor deliver these papers himself.* If the inventor goes, the manufacturer will be tempted to dicker for more favorable terms. Inexperienced in business matters, the average inventor is likely to commit himself to subtle changes in the contract that may afterward prove important (such as, in my case, omitting the word "annual," which cost me several thousand dollars). Let the broker handle the business end of the arrangement and give him authority to close the deal under the terms of the contract only. Draw up the contract and stick by it; the broker will conclude the deal for you.

If he is wise the young inventor consults a reputable patent attorney, who gives him all the advantages and safeguards of years of experience, and who sees that his rights are protected and that his profit is adequate

John L. Baird with his sending apparatus in London sending a dummy by television to America just before he sent a living face. Left: Receiving the image, seen in left side of cabinet

Attic Inventor's Magic Eye Sees Across the Ocean

By H. C. Davis

TELEVISION sets for the home went on sale in London recently at $32.50 each. Back of that fact lies one of the most inspiring stories in the annals of modern invention.

Less than three years ago John L. Baird, a young Scotch inventor, working on a system of television, was walking the streets of London, sick and almost penniless. His home and workshop was a cold little attic; his laboratory apparatus consisted of soap boxes and tin cans tied together, and old bicycle parts. Desperate need of equipment to continue his experiments had driven him to sell a half interest in his invention for a few pounds.

That money went quickly. With but two pounds left and no prospect of more, he happened to meet a long-lost friend. That chance meeting saved Baird's invention. The friend was Captain O. G. Hutchinson who, in Hartsdale, N. Y., a few weeks ago, was on the receiving end when Baird, from his London laboratory, sent the first television picture of a living image flashing across the Atlantic. Now he is arranging for the introduction of the Baird television set into American homes.

Baird, now in his late thirties, was born in Scotland, the son of a Presbyterian minister. When twelve years old he saw his first motion picture show and left the theater with his boyish mind whirling.

If one mechanical invention made photographs move, why couldn't another, he asked himself, make them talk? He set himself to work on a "talking movie." It led him, through a score of heartbreaking years, to television.

The boy, never robust, spent long hours convincing himself that in the development of light-sensitive cells lay the secret of talking films. He improvised a laboratory and began experimenting, first with selenium cells.

His hands were terribly burned in handling an acid substance, and necessity forced him to work in an engineer's drafting room. The job paid his tuition in the night school of engineering in the University of Glasgow.

DURING the World War the young engineer, rejected for military service because of ill health, invented the "Baird Under-Sock," made of chemically treated cloth, for the relief of trench-foot. With his first working capital he was about to set up a laboratory when he fell seriously ill from overwork. Seeking health, he went to Trinidad in the West Indies, and lost all his money in a jam factory.

Back in London, he rented an attic in the Soho district and assembled his contraption of soap boxes and biscuit tins, and so forth. There he lived and labored, starving himself to buy equipment. One day, just as his experiments seemed to promise success, he learned that a German inventor had beaten him by years to the secret he sought, and held all existing patents on the speaking movie!

A staggering blow, but it failed to daunt him. His experiments with light-sensitive cells had led him into the possibilities of "seeing in darkness," and on that he concentrated his toil and study. One evening, sitting on the roof of his attic, watching the sun set over London, he remarked to a friend:

"I wonder if the infra-red rays, the invisible rays which lie just beyond the red that we see, could not be used to bring about sight in darkness? We may be able to find some way to use those rays."

He went into his laboratory, ate his usual meal of a bun and tea—then went to bed for a week! Partly from the necessity of conserving his strength, partly to keep warm, he did all his heavy thinking in bed in those days. At the end of the week his friend returned. Baird greeted him with a slow, cautious statement that he had "something interesting to show." A man on the floor below was a ventriloquist. From him Baird borrowed a papier-mâché dummy and stood it in the pitch-black laboratory. Then in an

(*Continued on page 124*)

They found Judy listening intently to an old Swiss model maker as he explained the mechanism of a two-foot dinosaur model

The Movie Maker

A Romance of Camera and Screen

By S. W. NEWMEYER—*Illustrated by ERNEST FUHR*

Already a marvel of perfection, the motion picture offers seemingly limitless fields for ingenuity. A distinguished French inventor, Rodolphe Berthon, for example, has just demonstrated a new process of producing movie scenes in all their natural colors, and at a cost no greater than that of the usual black and white films. Secrets of many new discoveries and devices that lie behind our elaborate screen dramas are told in "The Movie Maker"—an absorbing novel of romance and adventure on a background of mechanical and scientific fact. Here the true wonders of the movies stand revealed.—The Editor.

YOUNG Don Kennedy's only assets, when he ventured into the production of a big feature picture, were an ingenious invention of his own, an amazing stock of courage, and a talented little script girl, Judy Burke. The invention was a money-saving process of superimposing studio action upon scenic backgrounds filmed abroad. The courage was inspired by heavy odds against him. And the girl—well, she was just Judy. By assuming the expensive contract of a fading screen star, Margaret Moreland, Don obtained the free use of Popular Players' West Coast Studio for four months. Judy's brother, Jerry, a stunt flyer, joined the venture, as did Professor Mahrlenburg, an aged photographer. Despondent over the failure of her latest picture, Margaret tried to end her life, but was saved by Jerry. It was then revealed that she was really the old professor's daughter. With renewed hope she offered Don her services free, as well as financial aid. Don commissioned "Bozo" Biddle, an expert camera man, to photograph background scenes in Europe and Asia, while the others worked in the studio. The first month vanished, and so did the money. The venture was nearing the rocks when, through a clever scheme of Judy's, Don won the financial backing of Silas Rogers, wealthy newspaper owner, in return for giving his spoiled daughter, Mabel, a leading part in the picture. Teaching Mabel to act proved a big problem, but this and other difficulties were solved by clever tricks of photography and stage setting. As Don worked far into the night on the machine with which he combined backgrounds sent by Bozo from abroad with shots made on the lot, fire broke out in the house where he and Professor Mahrlenburg roomed. He saved the professor and his precious machines, but was driven to the roof and trapped there by flames. On a neighboring roof appeared a group of firemen, and with them Judy and Jerry. They extended a ladder to him. Just as a spurt of flame leaped toward him, he swung out into space on the rungs. Now read on:

ONE—two—three—four. Don's mind automatically checked off each rung of the ladder as he swung hand over hand across the twelve-foot gap toward the opposite roof. The heads of the firemen holding down the ladder end were just visible, but his eyes were riveted on a small figure near the roof's edge, as though the very intensity of his gaze were a steel cable pulling him to safety.

A sudden rosy glare illuminated the group of rescuers. So close was Don that he saw the startled widening of Judy's eyes and heard her moan as she hid her face. The ladder trembled . . . sagged. Lunging forward, he clutched the roof's edge with one hand, clung desperately, swung his other hand free . . . for an instant dangled between life and death as the ladder fell.

Behind him heat and roar and glare increased, but Don was only blissfully aware of the sharp, solid edge of the roof against his body as half a dozen hands dragged him up to safety.

Horses and riders plunged and foundered wildly as the sledge crashed through the thin ice. The pursuing sledge upset, spilling its riders out into the snow

Almost as if frozen into her crouched position, Judy looked at him, her face still stiff with terror.

Don stumbled over to her.

"I'm all right, Judy. Judy! Look—I'm not hurt at all."

But she continued to stare blankly at him, not moving. Patting her shoulder awkwardly, he half lifted her to her feet.

"Out of the way, there!"

Almost catching their feet in its flopping curves, a heavy length of fire hose was dragged past, writhing like a huge boa constrictor and swelling and stiffening into a rigid line as the water surged through it.

"All right, sis?" Jerry, who had been pulling and kicking the hose straight, now stepped over it to his sister's side, and Don suddenly realized that although the roof was swarming with firemen he was still patting Judy's shoulder and urging her—quite unnecessarily—to look at him.

The hearty, practical concern in Jerry's voice broke the spell. Don's arm dropped awkwardly and Judy, startled, turned to her brother.

"Of course I'm all right," she replied; but her voice, oddly high-pitched and strained, broke in a half-hysterical laugh. "I'm not the one who has just crawled out of that—that hell!"

SHIVERING, she made an attempt to square her shoulders, then locked arms with Don and Jerry as they moved closer to her. For a moment the trio stood motionless, gazing in silent fascination at the fire. The corner where the skylight had been was a roaring furnace, and the flames were now eating their way down the outer wall of the house in spite of the hissing stream pouring from the nozzle of the fire hose.

"Let's go down," said Judy in a tired voice. "I've had enough of this."

"But what I can't understand," puzzled Don, as they clambered through the trapdoor of the roof, "is how you and Judy got here so quickly."

"Evidently the professor phoned us first," replied Jerry, "for we followed the fire engine down the street. If it had to happen, I'm glad it wasn't over the week-end while we were at the ranch."

"Do you think the professor and I can find room at your hotel for a few days, till we get new living quarters?"

"I'll fix it up," Jerry assured him. He and his sister, during the filming of the picture, had been staying at a small family hotel in the downtown section of Los Angeles, near by.

BUT when they reached the street, they found that other arrangements had been made. Wide-awake, and apparently enjoying the excitement, the professor was ensconced in Margaret's big sedan. On the floor of the car Don caught sight of the bundle containing his precious machine. Piled on top of it was the drying rack, broken, but with the torn and tangled ribbons of celluloid still wound around it.

Seated behind the wheel, Margaret held out both hands to Don as he approached.

"Don! We're so glad," she began, then noticed the gaping crowd pressing around the car. "Jump in beside father," she continued briskly. "I'll have you home in no time."

In vain Don protested against inconveniencing her. She would not hear of his going to a hotel, at least for the remainder of the night. So he got in beside the professor and sank back gratefully against the soft upholstered seat. As they rolled away, he noticed how small and tired Judy looked as she drooped against her brother. Some day he'd make it all up to her with something more substantial than words. Some day . . . "with all my worldly goods" . . . .

A swift flash of reality cut short Don's daydream. He smiled grimly as he reminded himself that the only worldly goods he had at present for endowment purposes were debts.

* * *

All afternoon Mr. Rogers' car had been parked outside the big wooden fence around Cinema City. It had long ago grown dark. Mabel, impatient for her dinner, had departed in a cab. Extras, principals, technical men and mechanics had gone their

several ways. And still two men sat on opposite sides of the long table in the general manager's office, playing chess with words.

Don wondered how much longer he could control himself. He longed to reach out, yank that short stocky figure across the table, and batter the crafty, yellow-mustached face to a pulp. All afternoon he had listened to that suavely triumphant voice criticizing, objecting, bullying, ridiculing. All afternoon he had fought back rage—reminding himself that no outsider could possibly visualize a completed picture from disjointed projection room rushes, that the man who paid the piper must be allowed to criticize the entire orchestra, that—

"And the agreement distinctly states that the second payment is to be made only if I am satisfied with the progress of the picture," rumbled Mr. Rogers accusingly. "Now, in the first place, Mabel—"

"I know that line by heart!" Don almost shouted. He leaped up, pushing back his chair with such violence that it banged over on the floor. "You want close-ups of your daughter. It took twenty-five thousand dollars' worth of energy and exasperation to get even the long shots. I can't guarantee close-ups of Mabel for any amount of money—I'm no miracle man. If you're not satisfied with our efforts to date, take your money and your contract and your daughter and get out!"

"Now, Kennedy, let's talk this over peaceably." In Silas Rogers' now softly modulated voice, in his watchful, deep-set eyes, Don recognized the source of Mabel's stubbornness, most baffling when it was mildest. Her astute father, looking up at the worried, angry young face above him, continued in a tone of kindly concern. "Really, my boy, you mustn't let your nerves go to pieces. You should take a little rest."

"I intend to when I finish—or stop—production." Don thrust his clenched hands deep into his pockets as he began to pace the floor. "And that's what it comes to. No use arguing any longer. You can withdraw right now if you want to. If I can't find another backer, we'll just stop production."

"And what about the twenty-five thousand I've already invested?" demanded Rogers.

Mabel burst into tears and sank down on a large rock beside the mound of the property grave, while Tim ground away steadily

"When it falls due you can take your share of the unfinished picture—"

"Not to finish it would be a greater loss to you than to me," warned Mr. Rogers, not so suave now. "And since we can't agree, why not accept my offer to change the security to a half interest in your universal background invention? I'll give you the additional seventy-five thousand dollars for that at once, and you can go right ahead with production on the picture without consulting me in any way."

"YOU'VE had my answer on that," replied Don shortly. "In a few years my invention will be worth a dozen pictures."

"But you'll have a hard time selling it unless you've produced a successful picture," commented Silas Rogers, a thin edge of malice in his voice.

Don strolled to the door and opened it.

"I know your time is as valuable as my own" he said pleasantly, "so I won't waste it. Good night."

A dull red flush spread over Mr. Rogers' face. He jerked out his check book.

"I'm not at all satisfied with the progress of the picture—not at all!—and you know it," he muttered, his studied calm at last broken, "but you're forcing me to protect my interests. Now I shall have to rely on your integrity to fulfill the conditions of our agreement."

Don concealed his great sense of relief with formal politeness as the newspaper Napoleon marched past him. Then he closed the door and smiled grimly. He had won that round of the chess game. He had taken Silas Rogers' queen without exposing his own king. The older man had been maneuvering all afternoon to obtain a stranglehold on Don's invention, and only that weary young man knew how close he had come. Now it was safe till the final round.

Out for a bite to eat at the near-by drugstore; then back to the office for further planning. The first week of November was nearly over and now Bozo was delaying the picture. Not a reel had been received from him since early October. The last reels were from Genoa—some bits of local color in the old seaport that antedated Columbus, views of the Mediterranean seacoast, and a final bit of a forsaken stretch of African shore where the crusaders in the picture were to be shipwrecked after capture by pirates.

DON, working into the night as usual, frowned as he spread out copies of the cablegrams he had sent to Bozo in an effort to learn the cause of the delay—Morocco, Constantinople, Damascus, Jerusalem. There were no other cities listed on Bozo's itinerary; by this time he should be nearing the end of his journey. That the veteran camera man was well able to take care of himself in any emergency, Don knew; but he was also aware that Bozo had a genius for getting into weird scrapes and hair-breadth adventures. He had taken with him a small projection machine and some short comedy reels—"to startle the natives"—he had told Don, and he had boasted to someone on the lot that he expected to take a few educational views on the side—"like a day in the sultan's harem."

Whistling thoughtfully under his breath, Don replaced the cablegrams in a file basket. He glanced at the desk clock—nine-thirty—and drew pencil and paper toward him to figure costs. If the Arabian scenes were not soon received from Bozo it would be necessary to transport the company, with extra people, properties, technical men and mechanics, to the Mohave Desert—five thousand dollars at least. Then there was the trip to northern California to get the snow scenes—the final episode in twelfth-century England. Don put a tentative two thousand in the column opposite, hoping he might shave it a bit. Three days work on the war shots, with a large force of extras . . . the renting of six additional cameras electrically operated, for the battle of the beasts . . . two airplanes and pilots with an extra five hundred for Lacey's crash stunt . . . three hundred especially prepared wash drawings of the air duel. . . .

With a muttered, half-fearful exclamation, Don threw his pencil across the room. His shaking hands wiped the cold perspiration from his forehead. It was twenty minutes after twelve, and nearly three hours he had been sitting there in a daze, neither asleep nor awake, scribbling automatically on the sheets that covered his desk. He snatched up one of them and started to tear it. He paused, however, folded it and put it into his pocket, slammed down the desk cover, and a moment later let himself out of the lot by a small door in the center of one of the huge wooden gates.

RAPIDLY he walked toward the outskirts of Hollywood. Though it was late, he knew it would be quite useless to return to the bungalow where he had been rooming the last week. Not once since the fire had he been able to get even a few hours of uninterrupted sleep. At first his high tension alertness—after weeks of fighting back the normal demands of his body for rest—had pleased him. He had been able to work more rapidly. The necessary minor repairs to his background machine—cracked lenses, easily replaced; a few screws tightened, bands adjusted—had been quickly accomplished. The torn footage of the reels rescued from the fire he had (*Continued on page 144*)

Secrets of Animal Talk Revealed

Words and Letters in Birds' Language Counted—Amazing New Experiments Show How Apes, Horses and Dogs Converse

By WARREN MAC DOUGALL

Dr. William M. Patterson, Columbia University language expert, and the African finch that has an "alphabet" of 24 "letters" and a vocabulary of at least 300 words, used to express definite feelings

"A BIRD is not really singing a song when it opens its beak; it is making a speech."

With that startling announcement, Dr. William M. Patterson, a research expert in language at Columbia University, a few weeks ago introduced to a group of distinguished psychologists a little gray and white bird, which, he declared, talks with a vocabulary of at least 300 words! The name of this bird is *Serinus Leucopygius*, or African finch. For two years Dr. Patterson has closely studied it and he has reached these conclusions:

Its notes, covering a wide range, correspond strikingly to the vowels and consonants of human speech. There are twenty-four "letters" in the bird's "alphabet"—seven vowels and seventeen consonants—grouped into words and syllables much like our own.

Moreover, the bird does not use the "words" haphazard, but apparently to give definite expression. For example, Dr. Patterson found that the finch, awakened at the same hour every morning, almost invariably makes a little speech which lasts just fourteen seconds! And always the same speech!

All of which has thrown interesting new light on questions which men have asked for centuries and which psychologists now are just beginning to answer:

Can birds and animals talk? And if so, shall we ever be able to converse with them?

Every person who has owned and loved a dog or a horse probably has often said, "That animal can do everything but talk." Now it appears he may be able to do that, too, in his own language. We do know that animals can express their changing emotions in unmistakable actions. A dog wags his tail when happy and growls when angry; a cat spits, purrs or rubs against your legs. That animals really think has been demonstrated, but whether they exchange ideas with one another by a strange but actual language that we do not comprehend remains in doubt.

That animals recognize words and sentences spoken by their masters has been proved repeatedly. Fellow, the dog whose amazingly accurate execution of complex commands was described in last January's POPULAR SCIENCE MONTHLY, can remember the name of a person and identify that person when the name is repeated. Flash, a police dog of the movies, has shown extraordinary intelligence in tests under direction of Dr. Karl T. Waugh, instructor in animal psychology at the University of Southern California.

AT THE International Congress for Psychical Research in Paris, a German expert, Dr. Wilhelm Neumann, recently declared that his dog Rolf understands what he says and answers with signals consisting of a series of barks. Thus they carry on what approaches conversation. Dr. Karl Krall told of a horse he had trained to spell the names of visitors, using an alphabet consisting of numerical signals tapped out with its feet.

All attempts to teach animals to speak human language, however, have failed thus far. The most interesting experiments along this line have been made with apes by Prof. Robert M. Yerkes of the Department of Psychology, Yale University. Years of study of these almost human creatures have convinced him, he says, that, while they possess high intelligence, they are mechanically incapable of forming human words, though they can imitate human actions.

Dr. Karl T. Waugh, animal psychologist of Southern California University, having colors identified by Flash, famous $100,000 police dog of the movies, who learned the colors in two lessons

STILL, they have a sort of language of their own. Prof. Yerkes was able to identify thirty-two strange sounding "words" with which a pair of chimpanzees expressed pain, pleasure and hunger. He concluded, however, that they were little more than emotional outbursts like the human "ouch!" or "ah!"

For weeks Prof. Yerkes attempted to induce a chimpanzee to imitate a spoken sound. Whenever he opened a box containing a banana, the animal's favorite food, he uttered a simple spoken sound, like "ba-ba," hoping to induce the chimpanzee to imitate the sound when it wanted food. Although the attempt failed, the animal did imitate Yerkes' facial expression in making the sound.

Incapable of the complicated nervous and muscular operations of speech, animals can, he said, imitate actions which convey ideas. This suggested a new possibility—that of conversing with animals by signs!

"The great apes have plenty to talk about," he said, "but no gift for the use of sounds to represent individual ideas. Perhaps they can be taught to use their fingers, somewhat as does the deaf and dumb person, and thus acquire a simple, non-vocal sign language."

Cars Our Readers Choose

Sixteen Experienced Motorists Advise Bill Crowley on Picking First Machine—Contrasting Opinions Help You Find Best Auto for Your Needs

By Martin Bunn

"GOSH!" sighed Gus Wilson wearily as he tipped his chair back against the wall and lighted his pipe. "I sure didn't realize what I was letting myself in for when I appealed to the readers of Popular Science Monthly to help me advise Bill Crowley what kind of a motor car to buy. Did you ever see so many letters in your life, Joe?"

"Most as many as Lindbergh got, I guess," chuckled Joe Clark, his partner. "I haven't totaled them up yet, but there's thousands in that stack and every single one of them has been read, too."

"All ready for you, Bill," Gus greeted Crowley as the prospective automobile buyer entered the Model Garage office. "These letters ought to make it easy for you to decide what car to buy. At any rate they'll show you what other people would do in your position. Let's go over this bunch just as I picked them out without trying to get them in any particular order. I'll read the top one. It's from B. Giegerich, of Pittsfield, Massachusetts.

"'Forget the light cars and consider your $2,000 all spent to satisfy your wife's vanity and your own. She will adore the rich upholstery and roominess of the larger car and you will admire the ease and quietness of an engine that can maintain a smooth, steady sixty miles an hour with the comfort and security afforded by added weight and larger wheelbase.

"'THE ideal car for you is the Studebaker Commander Victoria. It is cozy but roomy, and you have the kids where you can keep an eye on them. The Studebaker's superiority over other cars of its class lies in lower engine speed. It is the secret of long life, smooth running, fewer repairs and minimum oil consumption. The Studebaker holds dozens of world records for endurance and speed and has all the latest features such as four-wheel brakes, balloon tires, crank case ventilation, gas pump, engine heat indicator and so on. With what's left out of your $2,000 you can buy Mrs. Crowley a new hat and coat to match the upholstery.'

"That's one way of looking at it," commented Gus as he reached for the next letter. "Let's see what Peter Herzig, of Plainfield, New Jersey, says:

"'BILL CROWLEY has the money to invest in an expensive car, but his knowledge and experience in handling any kind of car amounts to plus nothing. His wife, who also will drive it, knows no more than he does. Therefore an expensive car would be a waste of money. I suggest that he buy a 1928 model Ford sedan for the following reasons:

"'It is the best value for the least money.

"'It will stand wear and tear better than the higher priced cars.

"'It is easier to operate and to care for a Ford than any other car, which in the long run will be a big advantage to the two inexperienced drivers.

"'Not only is the initial cost less but the upkeep of this new model Ford is much less than that of any other car thus far built.'

"That," said Gus, "represents exactly the opposite point of view. Of course, the final and conclusive test of how a car stands up is in actual service. That applies to any new model of any make. Here's what R. E. Ambrose, of Verdi, Nevada, has to tell you:

"'With a six-year-old and even an eight-year-old child riding in back, for safety's sake he must have a coach. He must have a six-cylinder car because he can choose from among the best sixes within his price range and because the six gives ease of driving in traffic and is easier to park than an eight. He has missed the joys of motoring long enough to feel entitled to the added benefits of a six, yet he would not fully appreciate an eight, even if he could afford it, until he has cut his motoring teeth on a car of inferior capabilities. Four-wheel brakes are essential for the safety of his precious cargo. So for tried and true quality, size, appearance, he can find nothing better than the good old Hupmobile.'"

"I suppose he recommends the coach because the kids couldn't open the doors and fall out," suggested Crowley.

"That's Mr. Ambrose's idea," agreed Gus. "The rest of his arguments seem sound enough, except the one about four-wheel brakes. All cars have them now.

"Here's one from a woman, Mrs. H. A. Thomas, of Indianapolis, Indiana:

"'I THINK Bill Crowley should buy a Chevrolet four-door closed model. Just because Bill has $2,000 is no reason for spending it all on a machine. This is his first car, and he should buy a dependable car—one that is easily driven and repaired at low cost. He should buy a four-door closed model so that he can drive it in any weather and because the children will not have to climb over the people in the front seat every time they get in or out. He needs four doors, not two.

"'This first car of Bill Crowley's is for use close to home—shopping, visiting, pleasure and business; and an inexpensive car is the most practical for such use.

One Hundred and Sixty Dollars Worth of Advice

Gus Wilson, veteran automobile mechanic, asked our readers in the February issue to help his friend, Bill Crowley, select a car. Thousands of letters of advice were received. And, after careful study, sixteen, for each of which $10 has been paid, are published on these pages. They are presented not as representing necessarily the views of Mr. Bunn or the editors of Popular Science Monthly, but as letters that may be helpful because they express contrasting points of view. Perhaps you will not agree with any of the writers. Certainly, you will recognize that some of the claims made are equally applicable to many cars. But here are individual opinions that should be of interest and value to everyone who is in search of information as to the relative advantages of various cars.

"These letters should make it easy for you to choose a car," said Gus. "They show what other people would do in your position"

"'On first driving a car the speed craze gets one—a light car will not tempt one into disastrous speed.'"

"Seems to be a difference of opinion on that four-door, two-door question," Crowley commented when Gus finished reading. "Which is better, anyway?"

"Being a bachelor, I can't answer that one," laughed Gus. "I never had to drive a car with children alone on the back seat, so I don't know how they act. Let's read the next one. It's from Otho A. Morris, of Kerrville, Texas."

"'Bill Crowley should first purchase a used car. It is a mistake for a person of average means, with no automobile experience, to buy a new car. We value things by comparison. After Mr. Crowley has been aggravated for a year or so with an old model he will know how to appreciate a new one, and he will know by experience just what new car will best suit his needs.

"'In his search for a used car he should not purchase too old a model, for that would disgust him with automobiles at the start. I would suggest an Overland touring 1924 model, the kind I have. It will take him where he wants to go and bring him back and be a fine little car. After he goes through a winter with it and discovers the disadvantages of celluloid curtains, he will know how to appreciate an inclosed model. Experience with an old car will make an automobile mechanic out of him by the shortest possible route. Then he will know how to take proper care of a new and more expensive car when he decides to make the change.'

"THAT," said Gus, "is one viewpoint on the used car question. I remember that letter, but here's another from Ralph Cummings, of Los Angeles, Calif. There's no getting away from the fact that their arguments are as sound as any of the others. Here's what Cummings says:

"'There is no good reason why Bill Crowley should purchase a new car. With $2,000 to spend he can get a really fine secondhand Cadillac not more than a couple of years old and in perfect running condition. All new cars are secondhand any way the minute you drive them a few miles, so why not let the other fellow suffer the loss of the first year's depreciation—which always is the heaviest, plus the war tax, delivery and conditioning charges and so on? A good secondhand Cadillac will outlast any new car at the same delivered purchase price, and he will have a better looking and more comfortable car, a car that will do him justice in any company.'

"So much," said Gus, "for the secondhand car question. Now, listen to Grandison Irving, of Yale, Mich.:

"'I would advise Mr. Crowley to buy a Nash six-cylinder sedan because it has the best bearing system, with seven main bearings, and full pressure oil feed. It has overhead valves with lubricated valve stems and rocker arms.

"'The oil drain and radiator drain are accessible without soiling the hands. Oil can be added to the supply in the crank case through a large, handy hole in the top of the engine without using a funnel like a French horn.

"'In addition to these features, Nash cars have fine bodies and the interior fittings are of the best. They don't change styles very often, so your car doesn't get to be a last year's model within a few months after you have bought it.'

"Of course," commented Gus, "there are other cars on the market that have some of the features brought out in this letter. And some of them wouldn't mean anything to the owner who has his oil changed by the service station. The point is that this particular combination of features appeals to this particular owner. Here's another, from W. S. Hoover, who lives in Albion, Pennsylvania, that stresses various mechanical features:

"'I SUGGEST that Mr. and Mrs. Crowley buy a Chrysler 72 coach. There is no rear door for their youngest child to open and tumble out. Although the Chrysler has been on the market less than four years, it already holds third position in dollar volume sales. It was the first car to combine acceleration with high speed, accomplished by using a small flywheel, 4.6 to 1 gear ratio, and a motor turning 3300 revolutions a minute, mechanical features such as the seven-bearing crankshaft, full pressure lubrication, oil and air filters, thermostatic heat control, invar strut pistons, motor supports mounted in rubber, rubber shackles, web crank case supports for main bearings, and the new turbulence cylinder head giving a six to one terminal pressure.

"'The coach is closer coupled than the sedan and Bill won't appear lost when driving alone. Mrs. Crowley will appreciate the beautiful interior of the body and the exceptional ease of handling.'"

"Whew!" gasped Bill. "My head is whirling already. That's all Greek to me."

Gus smiled. "It represents," he explained, "the point of view of the man who takes an interest in the mechanical features of his car. Naturally, mechanical features won't mean anything to you until you have driven cars for a while and even then you may never learn anything about what goes on under the hood. And if you do, you may figure things out that other mechanical features are more important to you than the ones mentioned in that letter. Well, let's get on to the next. Another woman—Mrs. Grace H. Murphy, Melrose Park, Illinois:

"'I CAN'T think of one reason why Bill should have a car, but I can think of fifteen thousand seven hundred and twenty-three reasons why he shouldn't!

"'First, last and always there is the matter of expense.

"'Second, think of the wear and tear on his wife's nervous system.

"'Third, garage rent alone will pay the premium on a $5,000 life insurance policy to protect his family.

"'Fourth, there's no reason in the world why Bill should pass everyone else on his way to work. Besides, the street cars are sure, safe and sane.

"'Fifth, it's easier to pay carfare than damages.

"'Sixth, Bill had better be spending Sunday in church and with his family than in the garage.

"'Seventh, with an automobile Bill and his family *(Continued on page 142)*

Science's New Gifts to You

Most Perfect Telescope Mirror Is Cast—Children Immunized From Tuberculosis—Ants Have Fire Departments—Artificial Sea Proposed for Sahara Desert—Mastodon Skeleton Dug Up

Experts gingerly broke away the covering of a huge sand mold at the U. S. Bureau of Standards recently and were overjoyed to see within a flawless 70-inch disk of glass—largest telescope mirror ever cast in America and most perfect of its size in the world. Until now they had not known whether the mold contained the disk or only bits of shattered glass. Eight months before, after four efforts had failed, molten optical glass at 2,400 degrees of heat was poured into the electrically heated mold. The temperature was lowered for eight months. The 3,500-pound disk, 11 inches thick, is part of the telescope (right) given to Ohio Wesleyan University by Professor and Mrs. Hiram Perkins. It is free from the slight defects of the 100-inch Mount Wilson Observatory and the 72-inch Victoria, B. C., Observatory reflectors. Above, at the opening of the mold, are, left to right, W. R. Warner, Cleveland telescope mounting maker; S. W. Stratton, head of the Massachusetts Institute of Technology; and P. H. Bates, A. N. Finn and G. K. Burgess, all of the Bureau of Standards

Newest achievements in scientific research, discoveries, and inventions that concern us all by their bearing on the affairs of everyday life are recorded from month to month in these pages.

Ants Have Fire Departments

THE discovery that some ant hills have fire departments has just been made by Mlle. Marguerite Combes, French naturalist. She placed a lighted taper on a hill and a battalion of ant firemen extinguished it. Some squirted liquid formic acid from their jaws on the taper. Others tore at it. Many perished. One hero dragged another from danger.

Mortals are just beginning to understand how "human" the insects are. Paris recently has opened an insect "zoo."

Artificial Sea for Sahara

BEFORE many years, ships may sail into the heart of the Sahara Desert, calling at ports which will have risen from the barren sands. A vast engineering plan proposed by Dr. John Ball, of the Geological Survey of Egypt, would create an inland sea, thousands of square miles in area, covering the northern part of the Libyan Desert, northwest of Egypt, much of which is below sea level. It would be filled by a 200-mile canal running to the Mediterranean Sea, big enough for ocean liners.

Evaporation from the inland sea, says Doctor Ball, should increase rainfall, making arid lands fruitful.

New Auto Engine to Save Gas

FIFTY percent more mileage to the gallon of gasoline—a yearly saving of some $400,000,000 to American motorists—is promised by Prof. H. M. Jacklin, of Purdue University, with a revolutionary motor designed to operate at constant instead of variable pressure.

In present engines the compression space in the cylinders remains always the same, whether the automobile's speed is high or low. Consequently, the pressure when the throttle is nearly closed is much below the most efficient point because of the small charge drawn into the cylinders. Professor Jacklin claims to have devised a movable cylinder head which reduces the space in the cylinder when the charge is reduced, keeping the pressure constant.

This, he says, should cut fuel bills one third. At twenty cents a gallon, the saving would pay almost half of the nation's annual automobile repair bill, which, in last month's issue of POPULAR SCIENCE MONTHLY, was estimated at a billion dollars.

Ultra-Violet Glass on Trial

THOUSANDS of persons have been asking lately about the health-giving value of the new substitutes for ordinary window glass, designed especially for use in homes, schools, sun parlors, office buildings, animal houses and green houses. In response, the U. S. Bureau of Standards has just announced results of tests of these glasses, revealing their relative properties of transmitting the invisible and beneficial ultra-violet rays of sunlight.

Direct measurements were made during noon hours of clear days from April to December last. The tests showed that ordinary window glass transmits little if any ultra-violet light. Fused quartz glass transmits ninety-two percent of the invisible rays, as does the best of the patented glass substitutes. Others transmit fifty, twenty, five, and one percent respectively. Two widely known substitutes, however, were found to deteriorate somewhat rapidly with exposure to sunlight. Exposure of one sample for 123 hours decreased its ultra-violet transmission from forty-seven to thirty-five percent. Other samples were only slightly affected.

In other tests, two experts of Toronto, Drs. Frederick F. Tisdall and Alan Brown, report the effects of the ultra-violet rays are very slight except immediately back of the window. In order to benefit, they declare, one must receive the direct rays of the sun.

Motor Car That Can Swim Devised to Explore Alaska

MECHANICAL ingenuity serves the modern explorer in many ways.

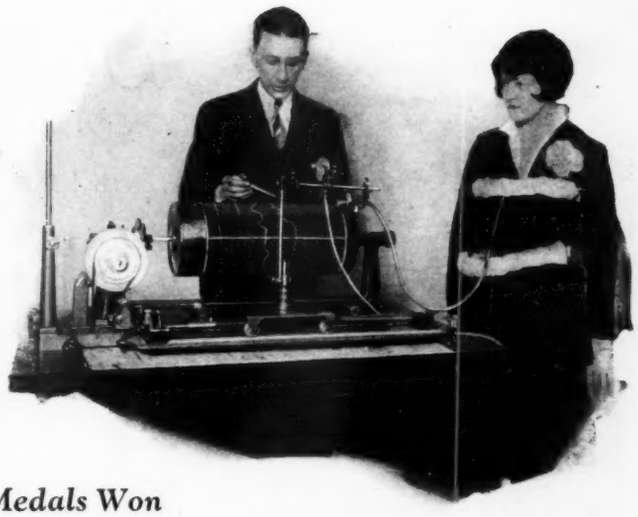
Dr. T. A. Jaggar, head of the Hawaiian Volcano Observatory, plans to explore uninhabited volcanic islands of Alaska, where the shores are forbidding and safe anchorage is hard to find. To solve the difficulty, he is building a curious amphibian auto. It is a sixteen-foot boat mounted on a chassis and propelled by paddle wheels driven by the engine. When it reaches shore, it climbs up on its own wheels and drives away.

In the valley between the Tigris and Euphrates rivers, explorers are planning to use airplanes to map the irrigation canals and town sites of ancient Babylonia, lost and forgotten for nearly two thousand years. Time-worn landmarks which cannot be distinguished on the ground may be observed from the sky.

Sunken Island Is Grumbling

QUEER things happen to the earth. Between the islands of Java and Sumatra in the Dutch East Indies stood another island, less than half a century ago. On that island a mountain, Krakatoa, blew up in 1883 with the mightiest explosion in history, killing 30,000 people. The noise was heard in Australia, two thousand miles away. The island sank. Now steam and ashes are spurting up out of the sea. Mighty forces are grumbling to be let loose. What next?

Perhaps the island will rise again, as happened recently near the Fiji Islands, where Falcon Island has reappeared after being submerged for many years.



Now you can actually see how the muscles of your diaphragm move in the pronunciation of every word through a curious machine (right) devised by Prof. C. E. Parmenter, University of Chicago. An attachment fastened around the chest and diaphragm transmits the muscular movements to a stylus which moves on a revolving cylinder, making a white line for a record. The invention was used recently in foreign language classes to determine whether the muscles moved properly to pronounce certain sounds that are difficult for students of foreign languages to utter. Every word of a student made its special mark

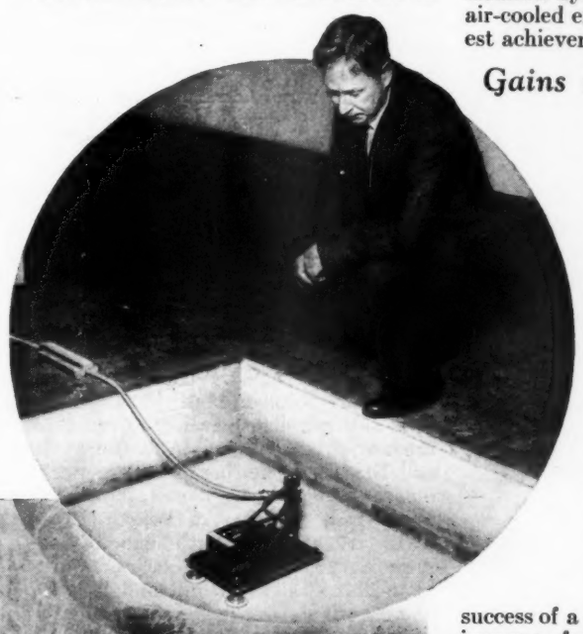
Three Science Medals Won

THREE Americans recently won highest honors for scientific achievement.

Dr. William D. Coolidge, Assistant Director of the General Electric Company Research Laboratory, received the Edison Medal awarded by the American Institute of Electrical Engineers for his contributions to incandescent electric lighting and the X-ray.

The John Fritz Medal was awarded to John J. Carty, Vice President of the American Telephone and Telegraph Company, for pioneer achievement in telephone engineering and research.

The Collier Trophy for 1927 was awarded by the National Aeronautical Association to Charles L. Lawrance, designer of the Wright Whirlwind engine used by Lindbergh and other trans-Atlantic flyers. His development of this air-cooled engine was termed "the greatest achievement in aviation in America."



A simple new seismograph to replace the cumbersome ones is seen at the right with its inventor, Dr. Frank Wenner, U. S. Bureau of Standards. When the earth trembles a coil of wire, suspended between poles of a magnet, moves, generating a current of electricity which is amplified, translated into light waves and led to a photographic film which records the vibrations. By the records of several of these instruments set up in various parts of the world, the location of a quake is shown

Gains in War on Disease

BLOODLESS and painless removal of tonsils was demonstrated recently by Dr. C. Coulter Charlton of Atlantic City, N. J., with an electric needle that causes the tonsils to dry up and vanish.

In Cornell University College of Medicine experiments with twenty-five students show that treatments with ultra-violet rays can prevent common colds.

In Charlottenburg, Germany, airplane trips to 10,000-foot altitudes have proved effective in curing whooping cough.

The French Academy of Medicine announces the success of a vaccine which makes children immune from tuberculosis—even those born of tubercular parents and living in unsanitary surroundings. The vaccine is called "Bacille Calmette-Guerin" after its discoverers.

Radio Tone Made Still Purer

MUSIC reproduced today by radio and phonographs seems well-nigh perfect. Further refinements, however, are promised by two new inventions.

One employs echoes from double loudspeakers to give sound perspective. It is the work of Leon F. Douglass, Menlo Park, Calif., inventor.

The second invention is a reproducing diaphragm of sheet metal so amazingly thin that a printed page can be read through it. Dr. Carl Mueller, its German inventor, says it reproduces delicate overtones which are dampened by the heaviness of ordinary diaphragms.

Bones of prehistoric monsters of many kinds have been found in an exploration of the wilds of South America by an expedition of the Field Museum of Natural History. Here Prof. E. S. Riggs, leader of the research and associate curator of paleontology, and Robert C. Thorne are shown digging up the skeleton of a mastodon, an extinct relative of the elephant, on the banks of a river in Argentina

Solving the Mystery *of the* Shape of the Earth

THAT the earth is lop-sided, flat on both ends, wobbling very uncertainly on an undermined axis, with her poles away off-side and her "middle bulging most ungracefully like an eccentric tomato," was the recently expressed opinion of Capt. George W. Littlehales, hydrographic engineer for the United States Navy, as he departed for Japan to enlist the aid of foreign nations in a United States plan to map the two thirds of the earth which lies under sea.

That the earth may prove to be a tetrahedron or triangular pyramid, with four faces and four corners or coigns, with the seas occupying the depressions and forming the faces of the pyramid, and the continents situated around the coigns and reaching out along the edges, is a theory which, advanced by W. Lowthian Green, English geologist, in 1875 and disregarded, has lately been revived by Theophile Moreux, French scientist, as one at least worthy of more discussion.

AS A matter of fact no scientist today would call the earth a "sphere." With the invention of invar, an alloy of nickel and steel which is practically nonelastic in any temperature, and which made possible a measurement of the earth's surfaces more exactly than ever before, the scientists have found that the meridians and parallels—even the equator—are not circles at all. And today they call the earth neither a sphere nor an oblate spheroid; they call it a geoid. What is a geoid? An "earth-shaped" body. What is an "earth-shaped" body? A geoid. It is a circle of question and answer that swallows itself, and leaves no one the wiser. But it does leave plenty of room for new theories and for reconsideration of many old ones.

The earth was originally conceived as a great flatland of infinite depth, which supported the heavens. Later, when men began to round the capes in ships, they imagined the earth as floating in a universal ocean of unknown extent (Drawing No. 1), and from this it was but a short step to the conception of the earth as bounded by a circle, with roots reaching downward (Drawing No. 2).

Another ancient figure of earth was a great flat supported by pillars (Drawing No. 3), but on what did the twelve great pillars rest? Religion answered, through the Vedic priests, that they were supported by sacrifices of the virtuous, without which the earth would collapse.

Anaximander, a Greek of the sixth century B. C., concluded that the earth was a cylinder (Drawing No. 4), whose diameter was three times its height, which floated in the center of the vault of heaven. Only its upper face was inhabited, of which the northern half was Europe, and the southern half Lybia or Africa, and Asia.

A little later Plato evolved his cubical earth (Drawing No. 5), holding that the cube with its six faces, being the most perfect of forms, should be the form of the dwelling place of man.

LONG before the Western world had begun to measure toward the spheroid form, the ancient East had imagined a spherical earth with great mountains to the north and south (Drawing No. 6). Here again, in this figure we see the conception of the earth held upright by a majestic pillar, or the world axis. But now they thought in hemispheres, and mostly in northern hemispheres. The northern half of the earth came to be, therefore, a great mountain, rising out of the equatorial ocean, and carried in

Drawings of early conceptions of the nature and shape of the earth as shown in ancient literatures

Scientists Say It May Be a Pyramid or Lopsided; Certainly It Isn't a Sphere. Many Strange Conceptions of Its Form Recalled in this Article, with Which You Can Send Your Mind Adventuring

By EDNA KENTON

imagination to the clouds and beyond them, to the abodes of the gods themselves. Where the southern hemisphere was figured it was a mountain inverted, connecting the earth with the abode of demons. But under various names, in most of the very ancient Hindu cosmologies, we can find this "Mountain of the World," at the North Pole of the earth (Drawing No. 7), connecting earth with the heavens, and serving as the axis around which the heavenly bodies revolved.

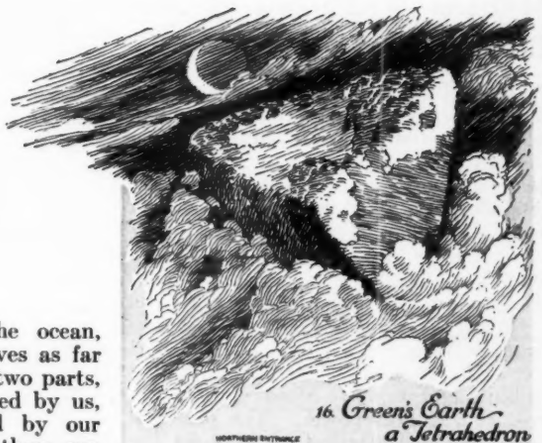
A later Hindu conception—and Chaldean likewise—was of the earth as a large shell (Drawing No. 8). The Hindus represented this circular shell as resting on the backs of four elephants, symbolizing the four elements, or winds; these rested on the back of a great tortoise, which symbolized variously strength, endurance, patience, creation, or eternity.

ANOTHER very ancient figure for earth, which, however, reached the Western world not more than fifteen hundred years ago, is the universal egg, floating in ether, sometimes on its side, sometimes erect (Drawing No. 9). Edrisi, an Arabian geographer of the eleventh century A.D., considered this egg, or earth, to be half plunged in water, that is, the unknown hemisphere was submerged. The Venerable Bede, of the eighth century, explains this figuration as follows: "The earth is an element placed in the middle of the world, as the yolk in the middle of an egg; around it is the water, like the white surrounds the yolk. Outside that is the air, like the membrane of the egg; and around all is the fire which closes it in as the shell does. The portion which is exposed to the torrid action of the air is burnt by the sun, and is uninhabitable; its two extremities are too cold to be inhabited, but the portion that lies in the temperate region of the atmosphere is habitable. The ocean, which surrounds it by its waves as far as the horizon. divides it into two parts, the upper of which is inhabited by us, while the lower is inhabited by our antipodes; though not one of them can come to us, nor one of us to them."

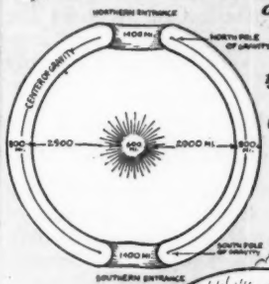
On a "tomato-shaped" form Ptolemy, in the second century, stretched his maps of the world (Drawing No. 10). The poles are in the middle of a great plateau. With this form as his working model, Apianus, in 1520, made his famous "cardiform projection" (Drawing No. 11), and through it obtained his heart-shaped map, supporting the revival by the Middle Ages of the old fancy that the earth is "the heart of God."

This cardiform earth map bears a curious, far-off resemblance to the earth of Columbus (Drawing No. 12) as deciphered from his letters. The old hemisphere, the eastern half, runs true to the spherical form on which he staked his all. But the new hemisphere, the Western world he was to unroll, rose to a lofty mountain at the equator. The "Mountain of the World" had moved, that is, from north to west. Columbus compared his earth figure to that of "a nearly round pear." Dante's earth (Drawing No. 13), a century earlier, had too its mountain, "The Mountain of Purgatory," but it was placed more than thirty degrees below the equator. "The City of Jerusalem," or Zion, exactly balanced it:—"Zion stands with this mountain in such wise on the earth that both have a single horizon and diverse hemispheres."

IN OTHER words, we can trace in his figure a survival of the far earlier antipodal world-mountains, once situated at the poles, but in Dante's *Divina Commedia* relocated to the northwest and southeast of them. (*Continued on page 140*)



16. Green's Earth a Tetrahedron

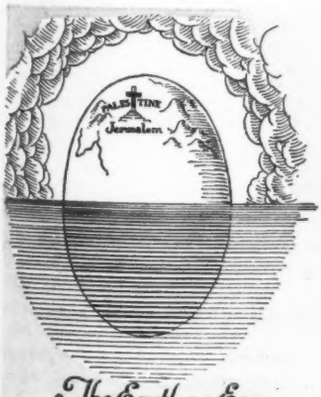


15. Gardner's Earth, a hollow sphere

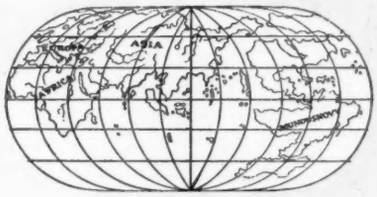
14. The Earth of Symmes—five concentric spheres

13. The Earth of Dante

12. The Pear-shaped Earth of Columbus

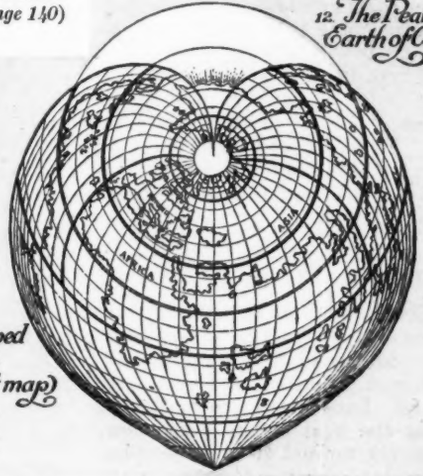


2. The Earth an Egg



10. The "Tomato-shaped" Earth of Ptolemy (A 16th century map, drawn over the Ptolemy form)

11. The Heart-shaped Earth (From an ancient map)



Strange Middle Age and later conceptions of the earth's form and nature, including some of comparatively modern times

Millions of Pounds of Air Blown Every Day in Organs

NEARLY fifteen billion cubic feet of air, weighing over eighteen million pounds, are blown through organ pipes in the United States in one day—a veritable gale—to supply music to those who attend churches, theaters and auditoriums, according to figures compiled by ventilating engineers who conducted a survey to show the importance of electrically controlled air in every phase of American life.

One of the largest pipe organs in this country, in a Philadelphia store, is 144 feet high, required 120,000 feet of lumber to build and uses five blowers, which aggregate 132 horsepower. The principal organ in the Cathedral of St. John the Divine, New York City, has four keyboards and a powerful blower to supply its 7,000 pipes.

Planes and Gas Fight Locusts

POISON gas is being used by the British Air Force in Egypt in a campaign of destruction against a colony of locusts, discovered near the Egypt-Sudan border, to prevent the insects from multiplying to a dangerous extent. When the Israelites were held captive in the Nile land and a swarm of locusts came up to darken the sky, Pharaoh pleaded with Moses to destroy the pestilence; but today the Egyptians attack the locusts and kill them off before they are able to fly.

Telephoning through the Sea

NEW methods of wrapping submarine cable make it possible to send and receive telephone messages by induction through the water, says Charles R. Withers, Chicago electrician, its inventor. In a recent demonstration an automatic sending and receiving set was submerged with a length of cable for its undersea antenna. Another cable, dragged through the water near the sunken transmitter, picked up its messages. The Navy will test the device, which Withers calls the "inductaphone."

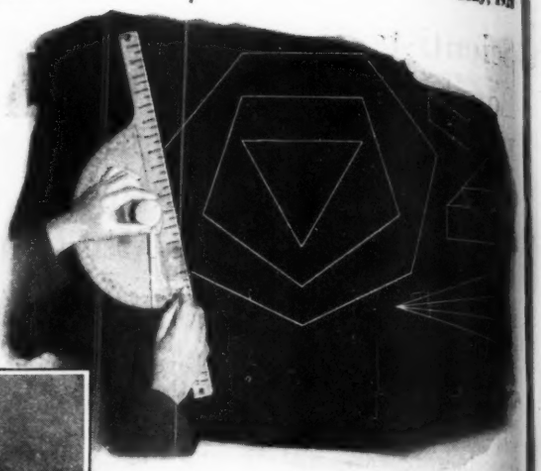
Automatic Typewriter Cover

TOUCH a spring and the new folding cover seen at the right snaps over your typewriter, excluding dust and dirt. When the machine is in use, the cover, which is permanently attached, folds back out of the typist's way; yet when she has finished it instantly closes to protect the two thousand or more working parts and bearings. The new device includes an attachment to hold sheets being copied, with an automatic line guide to help the typist find the place.

Hibernation Next to Death

WHEN the hibernating animals go to sleep for the winter their vital processes slow down and all but stop. Dr. George Edwin Johnson, of the Kansas Agricultural Experiment Station, has found that the beat of the heart slows down from the normal 200 to 350 pulsations a minute to only five to fifteen beats, while the breathing becomes so slow that it almost ceases, some animals, when asleep for the winter, drawing only one breath every two minutes.

The body temperature falls to about three or four degrees above freezing, and the animal loses about forty percent of its weight. Their gradual assimilation of the body fats is the only thing that keeps the animals alive while they sleep away the long winter.



Flowerpot Stand Aids Plants

YOUR plant or flower roots won't rot, it is said, if you keep the pot in this new holder and stand that has a drainage system built into it. The base or stand, which is a saucer to catch excess water, is separated from the container by three small legs, keeping the earth in the pot from becoming soggy with excess moisture, and thus preventing root rot. Open construction of the holder makes certain that plenty of light and air will reach the plant, keeping it well ventilated.

The device is made in both enameled iron and brass and comes in ornamental and plain designs for table or pedestal.

One motion closes or opens this accordionlike folding typewriter cover. An attachment above holds the stenographer's notebook when at work

Blackboard Drawing Device

ESPECIALLY designed for blackboard drawing is this novel protractor, useful to teachers of drafting, geometry, and engineering. Lay it against the vertical face of the board and its indicator edge immediately drops by gravity to a perfect plumb line; its graduations then permit instant drawing of accurate lines at any desired angle along its two-foot straightedge.

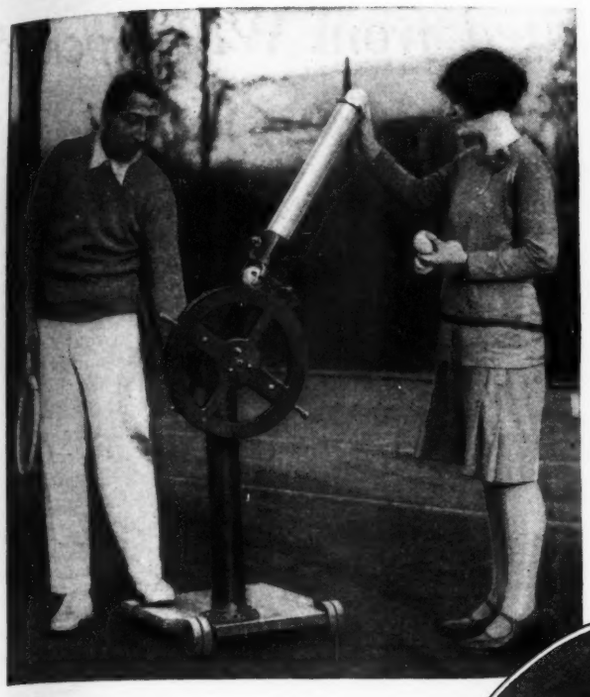
Air Fans Quiet Din in Tunnel

THE noises from the motor vehicles swarming through the Holland Tunnels, connecting New York City with New Jersey, are greatly reduced while the eighty-four giant ventilating fans are in operation, engineers have discovered. When the ventilating system is changing the air forty-two times every hour, the comparative quiet is a relief after the clamor of city streets. Tunnel engineers explain that the ventilation breaks up the sound waves before they can traverse the length of the highway under the Hudson.

New Power of X-Rays Found

A NEWLY discovered property of the X-ray is its power to change the effect of certain substances on light. It has long been known that certain liquids, such as a solution of sugar in water, have a curious effect on "polarized" rays of light shot through them from flat mirrors. Such rays vibrate in a single plane instead of in all directions as light rays ordinarily do; and after passing through the sugar solution, their plane is twisted through a definite and measurable angle. The amount of twist serves the sugar chemist in analyzing unknown samples.

Now Dr. Fred Allison, of the Alabama Polytechnic Institute, finds that certain liquids inactive upon such rays soon acquire the power of twisting them when exposed to X-rays. Rearrangement of the substance's molecules is the apparent explanation.



Mechanical Tennis Opponent

WHEN it's difficult to find a tennis player to give you a practice match —particularly one worthy of your mettle —try a mechanical man! That is what Rene Lacoste, French player, singles champion of United States, does, using this machine of his own invention.

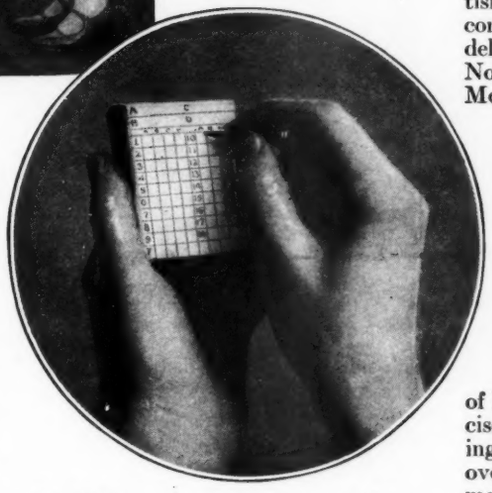
Lacoste's device, when placed in the opposite court, shoots a stream of balls over the net in simulation of four different kinds of strokes and does it so rapidly that its human opponent is kept continually on the run. It puts him to far more severe tests than could the average first-class tennis player. An electric motor operates the device, or it may be hand-operated by a person knowing nothing of the game.

Solving Secret of Glow in Sky

A NEW explanation of the faint glow sometimes seen in the sky in tropical latitudes, and less frequently in the temperate zones, is advanced by Dr. Elihu Thomson, director of the General Electric Company's research laboratory at Lynn, Mass., who says it may be caused by a "smoke" screen of fine iron particles. His laboratory experiments show such reflection when the smoke from iron electrodes used to produce an arc light passes through the field of a powerful electromagnet. Dr. Thomson suggests that the magnetic field of the earth would cause the same reflection of sunlight from natural clouds of iron particles above the earth. In his experiments the reflected light was found to be polarized; that is, confined to a single plane instead of spreading out in all directions. If the equatorial glow is found to be polarized Dr. Thomson's theory may prove correct.

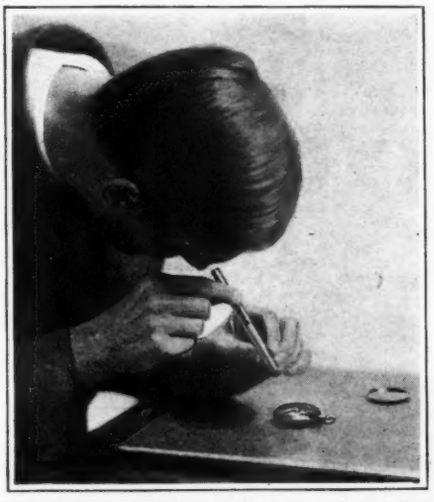
Highways to Link Americas

NORTH, Central and South America are to be linked by a great highway system, according to a proposal presented to the recent Pan-American Conference at Havana by the Peruvian delegation and approved by the entire conference. Dr. J. Salazar, of Peru, urged that "American states undertake joint efforts towards the construction of an international highway of such nature as to place them all in mutual communication"—in other words, to stretch the length of the three Americas. The United States enthusiastically supported the project; and the conference in a motion called upon the Pan-American Highway Conference, which meets in Rio de Janeiro in July, to take immediate action to make plans for the highway's construction.



Golf Tee and Pencil in One

GOLFERS whose memories fail in the stress of play and who are without a pencil to record the score will appreciate this latest convenience—a combination golf tee and pencil. Stick the tee in the ground like a tack and drive the ball off the flat top. The pointed end is also a pencil to jot down the strokes on the score card, printed on the tee box.



This focusing model microscope in a barrel like that of a fountain pen is steadied by an extension tip that rests on or near the object scrutinized

Unique Nonmagnetic Ship Seeks More Secrets of Sea

DEEP-SEA currents will be charted and the ocean's temperature at its floor taken by the nonmagnetic brigantine *Carnegie*, a remarkable craft which is to set sail this May on its latest cruise in the interest of the Carnegie Institution at Washington. Seven scientists and a crew of seventeen men will make the three-year trip planned. They will hoist deep-sea denizens and samples of ocean water from the bottom at the end of a three-and-a-half mile length of bronze rope, handled by a three-ton bronze winch.

In these fixtures, as in everything else about the unique vessel, iron and steel are conspicuous by their complete absence. Even the ship's auxiliary engine is without steel, except for its cams and pistons. This has enabled the *Carnegie* on its past half dozen expeditions to observe mysterious fluctuations of the earth's magnetism that upset the reading of mariner's compasses, and to measure them with its delicate instruments, as described in the November, 1925, POPULAR SCIENCE MONTHLY. The little yacht's findings in previous travels have enabled the U. S. Hydrographic Office to prepare magnetic charts that have aided safe navigation.

Hair Grows by Spurts

SHAVING does not increase the rate of growth of the beard. The ancient myth that it does is exploded by Dr. Mildred Trotter of the Washington University School of Medicine, St. Louis, after making precise measurements of sample beard shavings which were supplied by four students over a period of nine months. A total of more than 25,000 hairs was taken in all, cut at intervals of from twelve to ninety-six hours. From each sample 100 hairs were measured under a microscope. Dr. Trotter has found that the longer the period over which the hair is permitted to grow, the slower is the increase in length from day to day. Another result of the investigation is the conclusion that hair does not grow continuously, but in spurts, each of which is followed by a short rest.

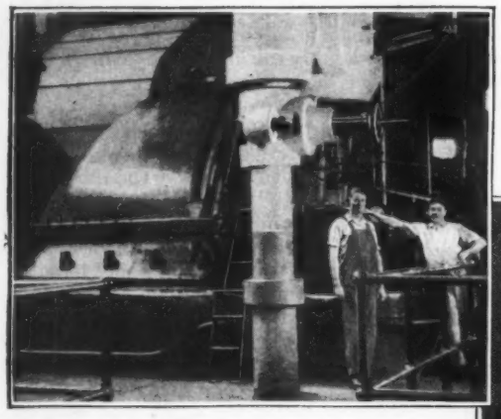
Microscope in Pen Barrel

LIKE a fountain pen in appearance is the newest pocket microscope, seen at the left, which houses a powerful lens. It permits scrutiny of minute objects that ordinary lenses would fail to reveal in detail. When the pocket magnifier, a focusing model, is adjusted, it is necessary only to place an extension tip on or near an object to be examined, and you see it greatly enlarged when you peer through the barrel.

What Do You Want to Know?

POPULAR SCIENCE MONTHLY is always glad whenever possible to answer readers' questions concerning any subject within its field. Inclose stamped, self-addressed envelope for reply and write to Information Department, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

New Clock Run and Regulated from Wall Socket



A huge generator in a Los Angeles power plant so regulated as to deliver uniform alternating current that will operate household clocks accurately

Power Houses, by Marvelous New Method, Regulate Speed of Their Dynamos by Official Naval Observatory Time So As to Make Millionth of a Horsepower Motor in Your Timepiece Move Hands Accurately

A MARVELOUS new clock without any mechanism, which is not only operated but regulated by electricity from your wall socket, is now available. And industry is indirectly benefited because the electric power that it receives is far more uniform.

Sixty times a second the "sixty cycle alternating current" that most localities receive flows, stops and flows in the reverse direction. Each complete cycle corresponds to one revolution of the giant wheel in the power house dynamo far away. Why not time a clock by it? That was the idea of the inventor who has just perfected the clock's tiny, millionth-of-a-horsepower motor that will exactly keep pace with that huge dynamo and uses but ten cents' worth of current a month!

The problem of regulation the inventor solved in an ingenious way, receiving full coöperation of the power companies. At each power station is installed a master clock set regularly by Naval Observatory time. For convenience it beats a five-minute instead of a twelve-hour dial. Every five minutes its single hand—black—goes round the dial. Above this hand a gold hand, not connected to the master clock, is run by an electric motor exactly like that in your electric clock. The power house simply regulates the dynamo speed so that the gold hand keeps pace with the black.

In industry textile mills are aided by the uniform current. It helps avoid tearing of fibers by irregular motion of looms, which sometimes happened with variable current.

Plugging the electric clock's connection into the wall socket. The current, alternating at sixty regular intervals a second, drives the clock's motor

The master clock time regulating arrangement installed in a power house to give uniform current. A black master hand governed by U. S. Naval Observatory time travels around a dial, and above it a gold hand governed by the dynamo goes round. The dynamo speed is regulated to make the gold hand keep exact pace with the black one

Tiny Sun, Earth and Moon Keeping Pace with Real Ones

FOR six years a miniature solar system has kept time with the universe. This machine has three globes representing the sun, earth and moon, and duplicates their movements. The small earth has a map of the two hemispheres on its surface and rotates on its axis as it revolves about the stationary sun. The ball which represents our satellite swings around the earth, keeping strict time with the moon's phases and eclipses.

The inventor, George E. Faucher, of Los Angeles, says his "time machine" follows the ancient Hebrew calendar with seven and a fraction extra days for each lunar year, making a thirteenth month in each fourth calendar year.

He Flies 18,000 Miles a Month

FLYING 18,000 miles each month is the record claimed for Pierre Robin, a French commercial airway pilot, by a Paris correspondent who asserts that in spite of this remarkable feat the aviator has failed to get a single mention in any newspaper. Robin makes the round trip between Paris and Berlin, which are 600 miles apart, every other day.

George E. Faucher and his "time machine," in which a clock has kept tiny models of the earth, sun and moon duplicating their movements for six years. The small earth has on it a map of the two hemispheres and rotates on its axis as does the real earth. It follows ancient Hebrew calendar with a thirteenth month in each fourth year

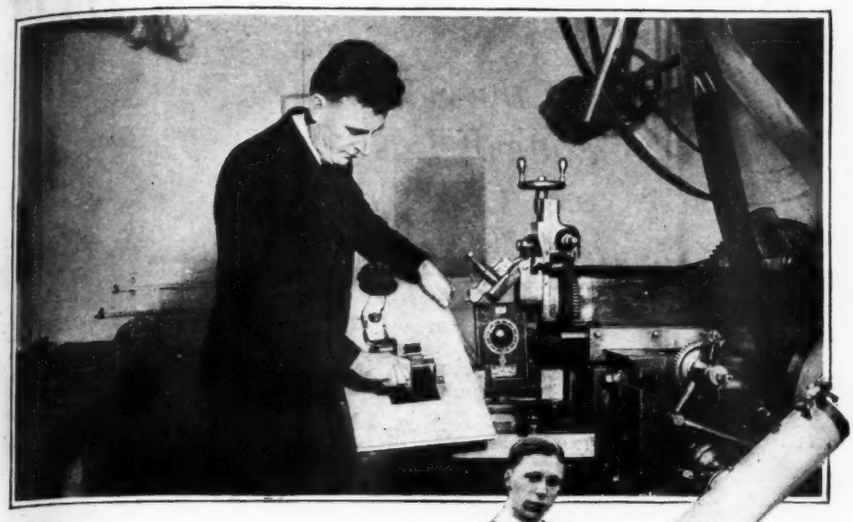
Millions of Gallons of Gas Saved by Light Tank Paint

LIGHT colored paint, when used instead of dark to protect gasoline storage tanks, saves more than 100,000,000 gallons of gasoline a year for refiners because the lighter color reflects sunlight, reducing the temperature of the tanks almost twenty degrees, and thus minimizing loss by evaporation, according to reports from the Master Painters and Decorators Association. Dr. Henry A. Gardner, of Washington, D. C., who made the statement, compared the light-hued coat to white clothes that make you feel cooler in summer, since they do not absorb the sun's heat.

Ship Fights Storm with Syrup

POURING a seventy-thousand-gallon cargo of molasses over a raging sea to calm the mountainous waves and save his ship was the resort recently of Captain Bush, veteran navigator. Two days out from Havana, bound for Philadelphia, his ship was overtaken by a furious storm. As a final resort the molasses was pumped overboard as a substitute for the oil sometimes used, and the experiment stilled the water around the ship.

Electricity to Rouse Sleepy Students

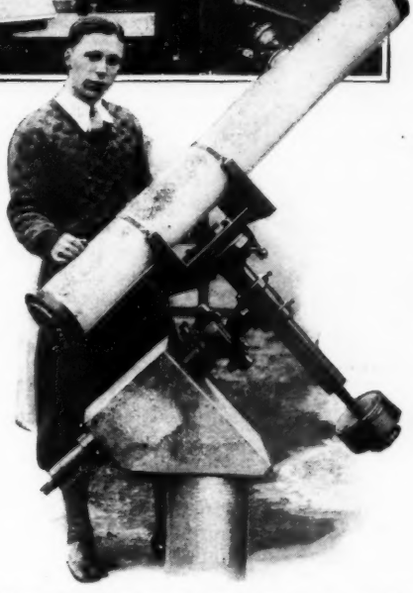


ELECTRIC alarm clocks may be installed in the dormitories of college students to ring them out of bed on time for their first morning classes, if the invention of Father Driscoll, of Villanova (Pa.) College, is utilized. Before going to bed each student sets a dial to the hour for rising, and a master clock electrically connected with each alarm rings it exactly on time. In this way, Father Driscoll, shown above at work in his machine shop, hopes to prevent the tardy attendance caused by alarm clocks that stop in the night or fail to ring in the morning.

Boy Builds Own Telescope

A JUNKED automobile has helped Leland M. Thurston, a sixteen-year-old Providence, R. I., schoolboy, to construct the telescope seen at the right, with which he scans the heavens nightly. Thurston made practically the entire telescope. The elevating and rotating parts are adapted from discarded units of the automobile, but the essential parts, the reflecting mirror and the prism, as well as the eyepiece, are the work of Thurston's own hands.

The telescope would cost $300 to replace, Thurston says. Developing a taste for astronomy at high school, he was dissatisfied with an ordinary, small refracting telescope and found that the Newtonian reflector he wanted would cost $100, ground and silvered. So he purchased the reflector "in the rough" and ground and silvered it himself. He similarly finished the prism, another delicate part. In spare time he spent nine months constructing the telescope. With it stars of the first magnitude may be seen in the daytime. A cobweb on a chimney top of a near-by house appears like a piece of rope through the homemade instrument.



Leland M. Thurston, of Providence, R. I., and the telescope he made of automobile parts and powerful reflector and prism that he himself finished. He constructed it in nine months, in spare time

Radio Patents Flood Britain

MORE than 1,000 inventions of radio devices and a host of important coal tar product manufacturing patents topped an exceptionally busy period for British inventors during 1927. The number of English patent applications exceeded 35,400, many more than in 1926. Women sought patents on cooking utensils, electrical toilet apparatus, nursery furniture, pleating machines, folding tables, and numerous other similar articles.

Coal Oil Distilled By New Process

TURNING a ton of cannel coal into a liquid, and extracting eighty-three gallons of crude oil, eight gallons of high grade gasoline, and a quantity of tar is accomplished by a new method by Prof. Paul Dvorkovitz, who in the photograph at the right is shown demonstrating his process recently in England. The residue left after the liquids have been extracted may yield a wealth of valuable coal tar products. The Dvorkovitz method is similar in some respects to those described in the March issue of POPULAR SCIENCE MONTHLY.

Prof. Paul Dvorkovitz drawing eighty-three gallons of crude oil from the container in which he has distilled it from a ton of coal by a new method that also yields a quantity of gasoline and coal tar

Nothing at All—a Vacuum—Worth Millions to the World

THOUGH you may never be able to purchase "vacuum" by the can—any more than you could go to the corner store and ask for a pound of "nothing"—a vacuum today is one of the most useful and valuable commodities in existence. Hundreds of millions are being spent in great industries that in one way or another use vacuums—literally holes punched in the air. To make even such a moderate vacuum as the one in the double-walled flask of your thermos bottle, to keep foods hot or cold, it is necessary to elbow aside the whole ocean of air in which we live, and of which every cubic mile weighs more than five million tons.

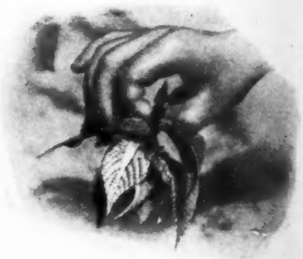
Why should anyone want a vacuum? In the electric lamp bulb, the filament that glows white-hot to light your house would burn up in a split second were it surrounded by air instead of an inert gas or the plain vacuum—nothing at all—that was formerly used. So would the filament of your radio "vacuum tubes." In odd ways the vacuum aids in the condensing of milk, in the coloring of wood, in the preserving of eggs and in many other manufacturing processes.

Condensed or evaporated milk would be spoiled by ordinary boiling. So the manufacturers boil it in a vacuum. Just as your pressure cooker enables you to boil water and food at far higher than ordinary temperatures, a "vacuum cooker" makes water and milk boil at surprising low ones, too low to injure delicate food. The same process is used in refining molasses and distilling soda fountain flavoring extracts.

Of course, there is no such thing as an absolute vacuum. The best we can do is to take out of a space *almost* all the air. Modern mechanical air pumps can remove all but about a thousandth part of the air from a vessel.

A Whole Farm in Your Yard

Growing Crop After Crop of Flowers on the Same Ground and Vegetables All Summer Long Is Easy By These Simple Methods That Anyone Can Use



Some plants can be made to grow more bushy by pinching off the growing tips, but you must first make sure that they are adapted to this treatment

By E. BADE

YOU are going to make a show affair of the garden in your front yard, which, of course, will be for flowers. Behind your house is a nice little square plot for luscious vegetables. Is there room, over there at the side, for a pint-size fruit orchard? Perhaps there is, at that.

This is a fine afternoon, and it's none too soon to begin on those gardens you've been planning. Your neighbor has stolen a march by starting his early plants indoors, but you may show him a thing or two yet. I see already one mistake he has made. His vegetable gardens run up and down his sloping yard. One heavy rain, and they'll be washed out. Mark yours out crosswise, and a deluge can't carry away the top soil.

Heavy wire can be bent into a circle supported by three legs to hold up the peony after its flowers, which are large and heavy, have developed

Let's start, though, with the flower beds in front. They can safely lie on a slant, if necessary, because your lawn will help hold their soil in place. You found that out for yourself when you bordered your walk with those tulips and hyacinths I see blooming.

Why not make your bulb garden do double duty? After the upper parts of the tulips have withered and died, sow seeds of the later-flowering annuals directly on the bulb beds, and the sooner the better, to make the flowers follow tulips or dahlias in quick succession. It won't injure the bulbs in any way, and it will change an unsightly summer plot of ground into a beauty show.

TALL plants at the middle, smaller ones toward the edge, dwarfs or ornamental leaf plants at the border—that's always a good plan, for an ornamental garden. You have all the seed stores' stocks to choose from, though I might suggest some good old standbys for the borders such as primrose or cowslip, "hens and chicks," English daisies, or funkia, an ornamental leaf plant which also flowers. When you have completed your choice, you have a garden that will be a riot of color from midsummer till late fall. They will start flowering even earlier if they have an indoor start. Pick faded blooms as fast as you see them; "going to seed" saps the plant's vitality.

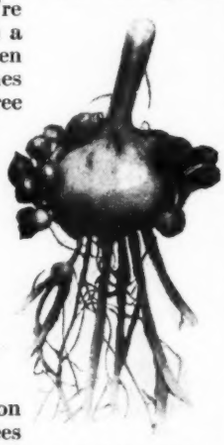
Perennials? Their flowers aren't, generally, as prolific as annuals (that grow, flower, and die in a single year), but have them by all means if you're willing to give them a little attention. When their growth becomes stunted — every three or four years— transplant them to a new bed in fertile soil, or, failing that, give them a tonic of liquid manure applied regularly during the summer.

NOW, how about an informal rock garden, filled with mountain plants? You'll find them vivid in coloring and large-flowered, despite the plants' diminutive size. Here's a good place in this corner—on sloping ground, where those tall trees will shade it a little from the most intense sunlight.

Scatter about a few large rocks, with smaller ones in between to set apart the beds and mass the flowers. Be sure that any rain water will run off, and your plants will thrive. They begin to flower early in spring, but you can realize the full charm of a rock garden only after the second year.

Above: Divide the dahlia bulbs after their winter in the cellar, cut off dead parts and plant them. Below: Circular bed made with sunken brick and edged with funkia, an ornamental plant

A word or two more about that bulb garden. In the fall, you'll dig up your dahlia bulbs and keep them in a frost-free cellar. When new shoots have appeared in the spring, divide the bulbs, cutting off the dead parts, and dig them into the ground. To multiply cannas, whose bulbs will have grown together, just separate and plant in the spring. Tiny seed bulbs grow on the mother bulbs of gladioli. Remove them and plant them separately, and they will flower after about a year in the ground.



A gladiolus mother bulb. Remove and plant separately the tiny seed bulbs. In a year they should flower

As for the vegetable garden, some of you town and city dwellers are cramped for space, but you can use the same ground over and over during the summer for different crops. Your first crop may be of lettuce, radishes, and onions from seed onions. The last-mentioned are small onions, not seeds. After you have harvested this early crop you may have a second, and even a third, of other vegetables before cold weather. Beans, peas, late beets and cabbage may follow the early plants.

If your first crop is late, sow the seeds of the second between the rows. The mature plants will shade the tender seedlings from the hot sun, and when harvested will give them ample room and light for their own maturity. And other plants such as lettuce can be sown afresh every two weeks during spring, summer, and late summer a few plants at a time, insuring a continuous supply.

Now, if your work has been well done, your flowers and vegetables will rival the pictures in the seed catalogues.

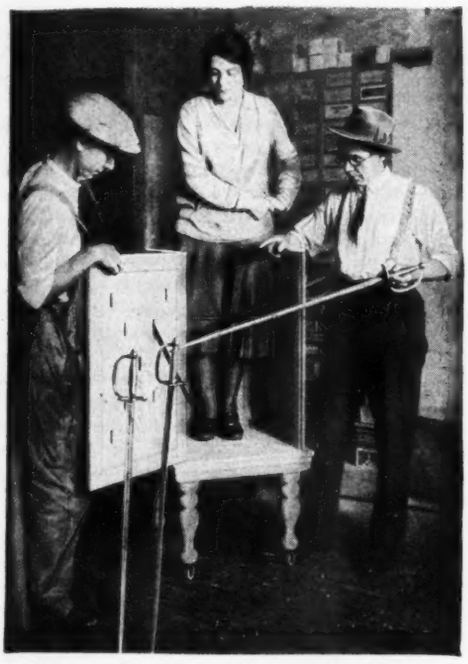
Snapshots *of* Unusual People

Yachts of Paper

Racing yachts with hulls of newspaper are made by A. Bisguard of New York

Tiniest Plant Makes 12 World's Best Accordions a Year

Frank Burko compares an instrument's tone with that of master-accordion played by his partner, Mike Emelianoff, on New York's East Side. Rich Europeans are patrons



Makes Tricks for Stage Magicians

For thirty years Floyd G. Thayer, of Los Angeles (right), has been designing and manufacturing apparatus for stage magicians. Here he is seen explaining the mystery by which a girl crouches in a box and swords are jabbed through it without hurting her

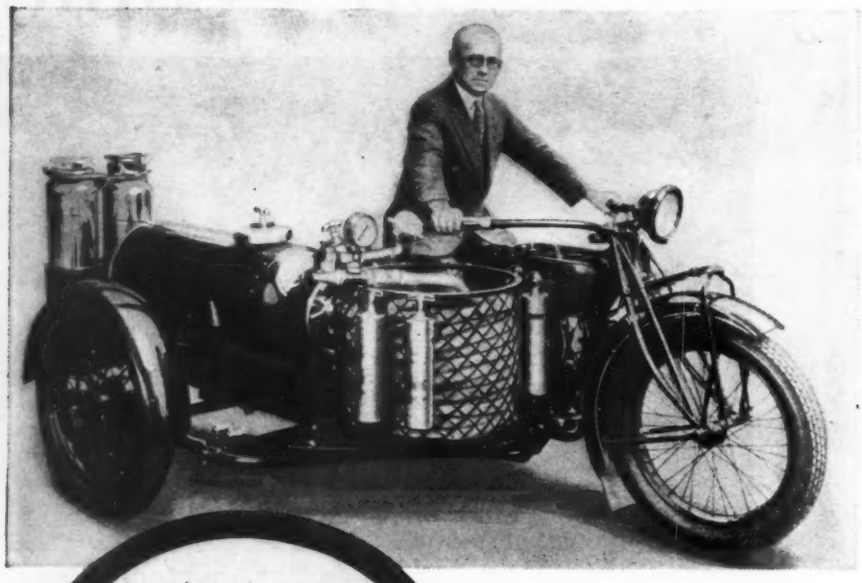
Designing Insignia Is Sergeant's Unique Army Job

Edward G. Kuhn, Coast Artillery Corps, 29 years in the service, designs all insignia used on clothing, pins, flags and so on, in every branch of the Army

Stout Hickory Rods and 24-Thread Lines Catch Swordfish

Ernest Grill, Jr., of the Balboa Angling Club, is seen landing one of the finny monsters off Catalina Island, Calif., in this remarkable photograph. All the speed, strength and strategy an experienced fisherman can muster to his aid are little enough for this job

Four Centuries of Bicycle History



The modern development of the bicycle—a complete fire department on wheels going 65 miles an hour—and the sixteenth century "bicycle." The rider was supposed to sit in the saddle within the large wheel which he turned by the aid of a hand operated crank

THE history of the idea of travel on wheels as developed by the ingenious minds of men through many hundreds of years is strikingly shown by two devices—one a twentieth century motorcycle fire engine, called the fastest and most efficient thing of its kind, and the other a sixteenth century arrangement of wheels, now in the Florentine Museum in Italy, called the forerunner of the modern bicycle.

From the queer early contrivance it is a far cry to the powerful modern machine that, with its lightness and speed, can reach fires ahead of larger apparatus, often in time to prevent their gaining headway. It races at sixty-five miles an hour with two firemen, forty-eight gallons of chemicals, 700 feet of hose, six extinguishers, one thick-headed axe, two steel brooms for grass fires, a pike pile for tearing down plaster and a four-foot jimmy for breaking down doors.

The sixteenth century vehicle was designed to be propelled by a hand crank; the rider sat on a saddle within the huge single wheel, turned the crank, and balanced himself precariously while it revolved about him.

The first ancestor of the modern bicycle, as we know it, is generally credited to a Scotch blacksmith, Kirkpatrick McMillan, who made a successful two-wheeled, foot-propelled vehicle in 1834. But the odd Italian "monocycle" antedates this by some three hundred years!

1,309,918 Light Bulbs In a City's Signs

NEW YORK CITY'S "Great White Way" (the theater district) now has 20,881 electric light signs since the addition of what is said to be the largest single electric advertisement in the world, a nationally-known automobile maker's sign. Made entirely of copper, it is 100 feet long and uses 8115 lamps, connected by more than twenty miles of wire, in letters sixteen feet high. Altogether, it is said, there are 1,309,918 electric light bulbs in use in New York's illuminated advertising today in comparison to one small sign first erected in 1888. These lights are used, among others, by 875 theaters, 3310 restaurants, 2260 barber shops, 1125 automobile garages and display rooms, 1098 tobacco stores, 1,060 tailors and clothiers, and 964 dentists and doctors.

Wave Length Used in Unison By Two Big Radio Stations

TWO thin waferlike slices of crystallized quartz, ground perfectly flat and kept at identical temperature by electric thermometers, effectively held two powerful radio stations on exactly the same wave length in a recent test of the radio stations WAIU, Columbus, O., and WGHP, Detroit, members of a national chain. No interference between the stations was noticed by listeners, who received the same program from both stations at the same time. Ordinarily, two stations attempting to operate in the same air channel would create an annoying squeal as one or the other's wave length varied according to the variation of its crystal's temperature. It was the perfect thermostatic control of the two crystals to make them work in unison that made possible this latest feat.

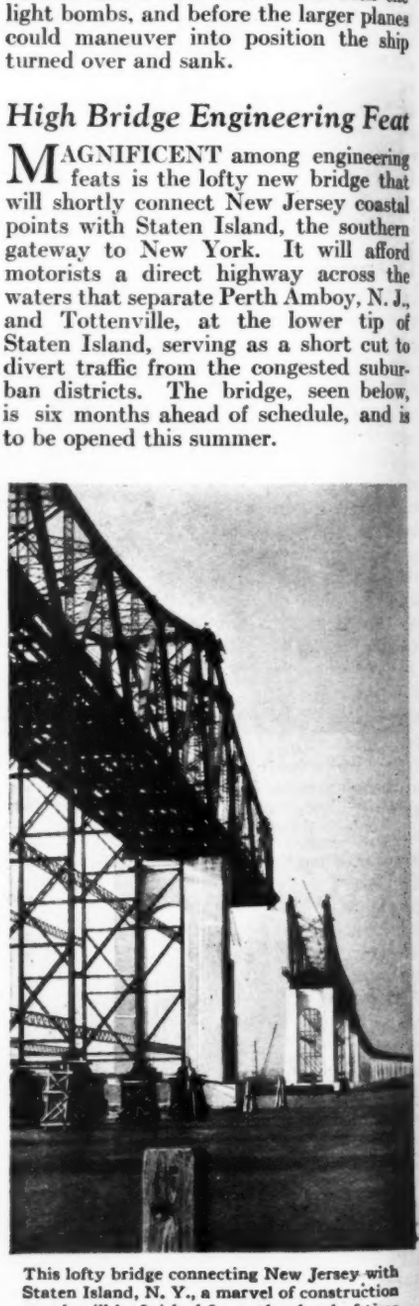
If all stations in the chain were to use the same wave length in this manner, it would, according to engineers in charge of the tests, vacate fifteen channels in the air which are now being used by the other stations in the chain. This would relieve much of the present air congestion, it is said.

Planes Sink Ship in Test

LARGE ships are becoming practically helpless against attack by air, according to Army Air Corps officers who recently witnessed a sham battle in which light pursuit planes rained twenty-five-pound bombs on an obsolete 5,000-ton ship. The theory was that if the steamer were a battleship these light explosives would drive the gunners from their posts so that heavier bombing planes might follow with large, high-explosive charges to sink the vessel. Several direct hits were made with the light bombs, and before the larger planes could maneuver into position the ship turned over and sank.

High Bridge Engineering Feat

MAGNIFICENT among engineering feats is the lofty new bridge that will shortly connect New Jersey coastal points with Staten Island, the southern gateway to New York. It will afford motorists a direct highway across the waters that separate Perth Amboy, N. J., and Tottenville, at the lower tip of Staten Island, serving as a short cut to divert traffic from the congested suburban districts. The bridge, seen below, is six months ahead of schedule, and is to be opened this summer.



This lofty bridge connecting New Jersey with Staten Island, N. Y., a marvel of construction speed, will be finished 6 months ahead of time

Now You Can Insure Home Against Wreckage by Planes

NOW you can insure your property against damage by passing airplanes, through a new type of policy that has already been taken out by a number of firms and individuals in this country. It may seem odd to arrange for a stated payment should an airplane collide with your house or back fence, but it is by no means absurd, declares an executive of the firm issuing the novel policy. In the last year, he points out, great property damage has been caused by airplanes making forced landings, though few persons have been killed in airplane accidents.

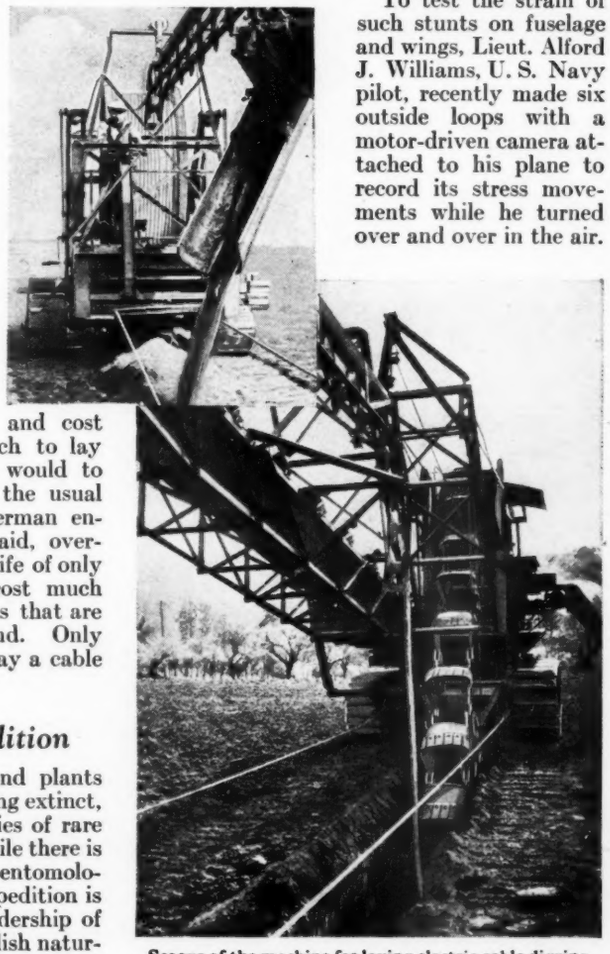
Weather on Air 6 Times a Day

AVIATORS planning transoceanic hops and navigators at sea may now tune-in on their radio sets six times a day for weather forecasts, the Department of Agriculture announces. Two broadcasts are specially intended for airmen and navigators, two are for European service, and the others are current weather observations received from special observers all over North America. These reports are not sent by radiophone, but by radio telegraph to insure greater accuracy.

Machine Buries Power Wires

HIGH tension electric wires are buried beneath the ground by a German invention which digs the trenches, lays the cables, throws the earth back in the ditch, and tamps it down.

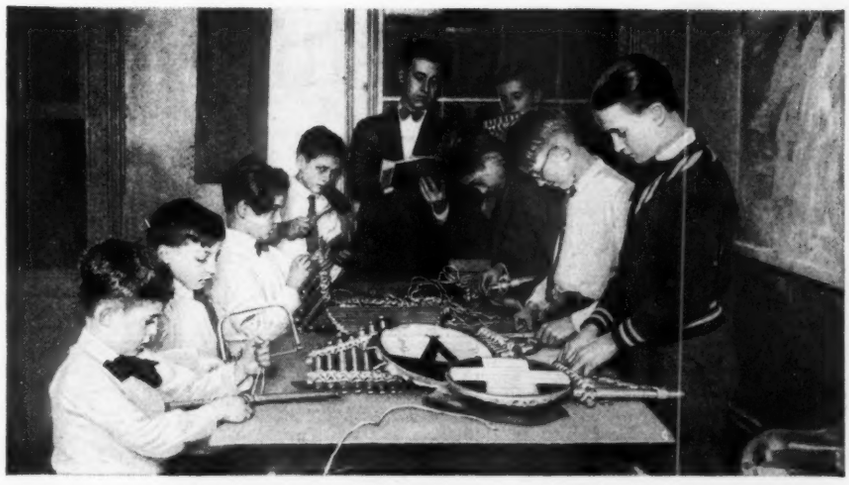
This machine, which advances the movement against overhead wires, goes over the ground on a caterpillar tractor. It has a belt of scoops that break the ground, shovel it up, and carry it to a chute which pours it back into the trenches. Another part of the same machine lays the cable in the ditch between the time it is dug and filled. Underground cables will last for forty-five years and cost about one eighth as much to lay with this machine as it would to string them overhead in the usual manner, according to German engineers. Besides, it is said, overhead wires have a useful life of only fifteen years, and they cost much more in upkeep than wires that are buried beneath the ground. Only five men are required to lay a cable by this new method.



Scoops of the machine for laying electric cable digging trench while the cable is fed into it. Above: The same earth, carried back in chute, poured on the cable

South Seas Expedition

MANY South Sea island plants and trees are becoming extinct, and with them many species of rare insects, scientists fear. While there is yet time for botanists and entomologists to study them, an expedition is being organized under leadership of J. Philpott Mumford, English naturalist now conducting similar research work in Southern California. Already $62,500 has been guaranteed by the Bishop Museum and the Hawaiian Sugar Planters Association to finance the three-year survey. Much of the information may especially benefit Hawaiian industries, but the search will be in the interests of science in general.



Flyer Loops Loop 1,111 Times

LOOPING the loop in an airplane 1,111 times without stopping, and keeping it up for four hours and fifty-six minutes, is the new record set by Alfred Fronval, acrobatic French aviator. This passes by eighteen loops the American record of Charles "Speed" Holman, an air mail pilot, made a short time previously.

To test the strain of such stunts on fuselage and wings, Lieut. Alford J. Williams, U. S. Navy pilot, recently made six outside loops with a motor-driven camera attached to his plane to record its stress movements while he turned over and over in the air.

Pupils Make Instruments

KNOWLEDGE of music may best be taught, decided Wesley G. Sontag, by experience in the construction of musical instruments, therefore he has started a class in the Greenwich House Music School, New York City, which makes its own orchestral pieces. Thus, Sontag believes, the children will readily discover for themselves the various stages in the development of the art.

To teach the fundamentals of pitch and tone quality, the task was set of making wooden marimbas. The photograph shows the class fashioning these instruments out of wooden pieces of various sizes which when tapped give varying tones of the scale. Since physical laws of vibration are the basis of various wind and string instruments, this teaching is said to be valuable in that it acquaints the student with the fundamentals which are applied in the construction of the instruments.

As Many Photos As You Wish

THERE is a new way, already in use in Europe, to make unlimited copies of photographs and other pictures without the aid of a camera! A plate coated with certain chemicals that have the peculiar property of glowing after exposure to sunshine is placed at the back of the picture to be copied and an ordinary photographic film pressed against the face for fifteen or twenty minutes. When the film is developed, it serves as an original from which any number of copies may be printed. The plate is "recharged" by exposure to strong light.

"Synthetic Grain" Proposed

"SYNTHETIC grain" created by crossing existing species of vegetation, making it possible to extract greater volume of nutritive substances from the soil with the aid of artificial rainfall, is all that Germany needs to turn it from a grain importing country to a self-supporting and grain exporting country, says Prof. E. Baur, of the German League for Technics and Science. Systematic research and crossing of varieties by methods like those of the late Luther Burbank, American naturalist, would result in a new and better grain, Prof. Baur believes. An increase of only fifteen percent would make Germany independent as to grain, it is estimated.

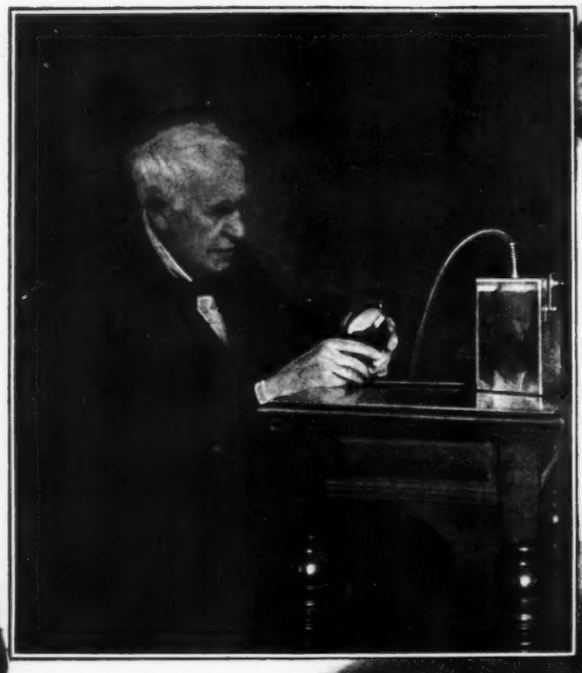
New Utilities Devised For Varied Needs

Camera Built Into Hand Bag

For the woman wishing to make picture mementoes of a scenic tour this device is designed. It serves usual purposes, but in addition an easily opened flap on the front contains a folding camera

New Hat Rack Saves Space

The flexible spring shaft carries your hat up toward the ceiling of your closet, where it is not in the way of other garments. A pull of the cord brings it within reach



New Edison Miner's Lamp

After more than 50,000 experiments the wizard, left, has invented a battery to produce a strong light indefinitely. The miner can carry it far into the works and there is no flame to cause an explosion

Speaking Tubes For Aviators

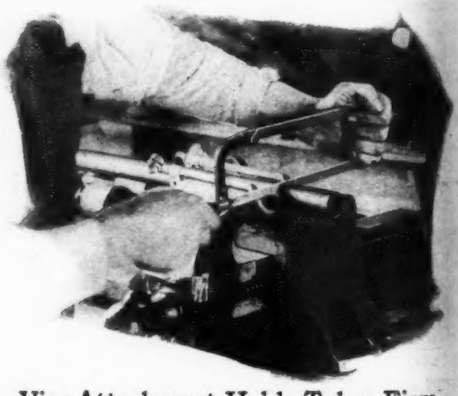
So passengers may converse with aviators, helmets with built-in speaking tubes, seen at the left, have been devised. The tubes go through the sponge rubber flaps, which press against the ears and exclude the motor's deafening roar

Wheelbarrow with Caterpillar Tread Will Not Cut Ground

This new English invention is also easier to handle on rough ground because with its flat belt tread it is less likely to tip. The idea is adapted from the tanks used in war

Bag Keeps Golf Clubs from Cutting Green

A box for balls attached to open end also serves to keep the heads off the earth. The women's model contains a vanity pocket also



Vise Attachment Holds Tubes Firm

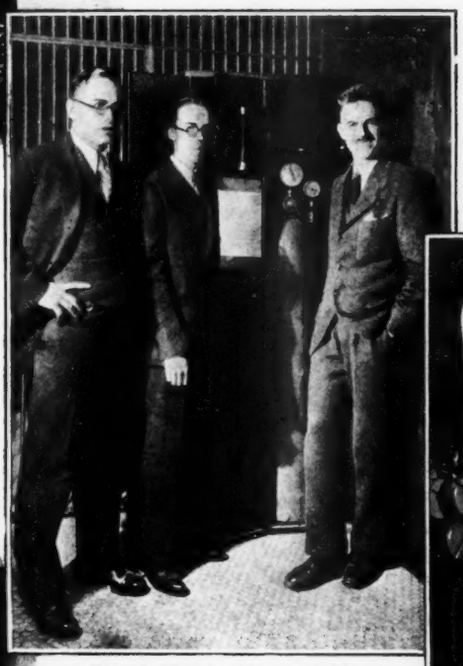
This holder, a U-shaped device of steel with the end bent down, will not allow the smallest tubing to slip

Umbrella Pocket in Bag

A flap on this week-end bag covers an outer pocket from which an umbrella can be whisked. It will particularly please those who wish ample protection, but want to carry as little luggage as possible

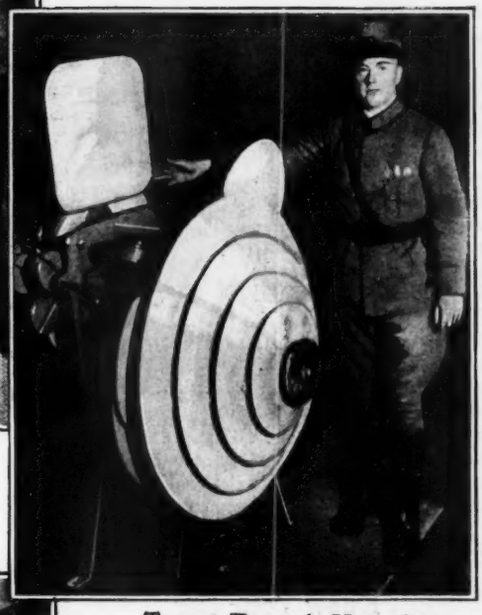
Typewriter Shifts Carriages

The ordinary carriage for letters can be detached in a jiffy and replaced with a long one for bookkeeping. To clean the machine you remove the whole outer frame by a touch on a lever, making all the mechanism accessible



Bank Vault Oxygen Tank

A new oxygen tank for bank vaults to save men accidentally locked in kept these men comfortably alive 12 hours



Target Records Your Score

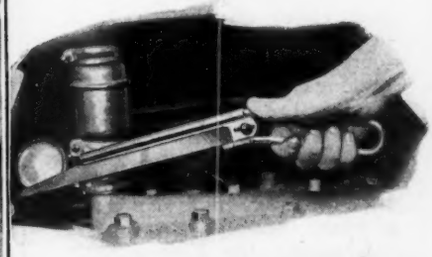
This new French Army target dispenses with the dangerous job of the tender, who risks getting hit by a bullet. The force of a bullet on any of the flat metal rings hoists signals showing exactly where the projectile struck the target

Device to Stop Gas Poisoning

Franz Franck, German chemist, is seen with his filter for illuminating gas lines. He says it contains chemicals to make gas nonpoisonous

Tides Operate Electric Buoy

C. J. Tobbell, English inventor, shows his new buoy whose dynamo, operating a light and a whistle, is run, he says, by the tides' action



Rigid Hack Saw Saves Blades

Breaking of hack-saw blades is said to be ended by this new frame. Fitted into the groove of its rigid "backbone," any blade can be used without bending. Another advantage is that it can be used in awkward places which, because of its shape, the ordinary hack saw cannot reach

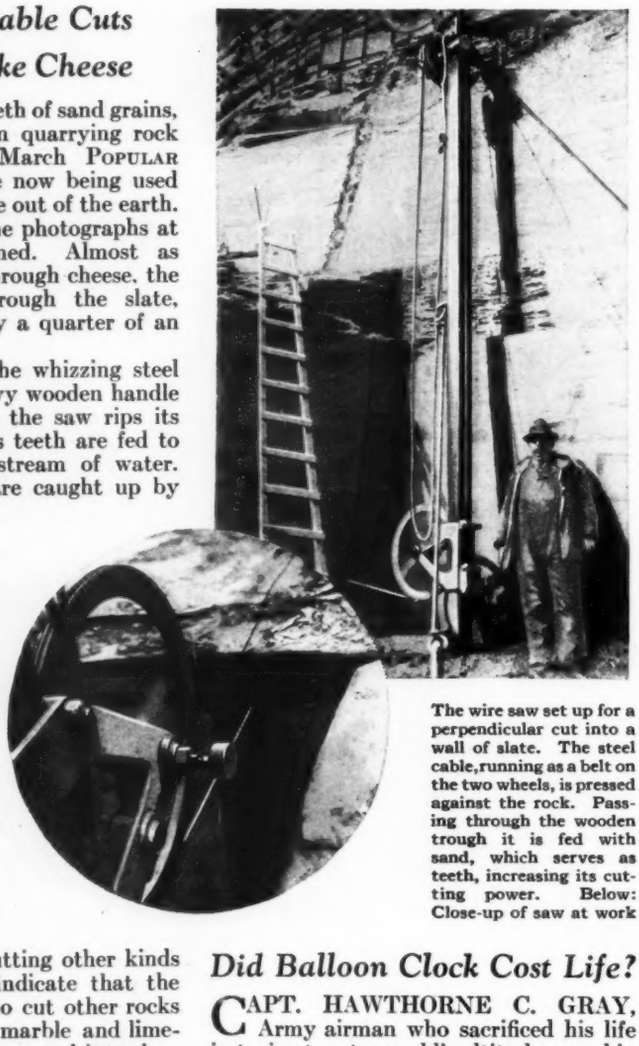
Clock Set in Floor of Bank

With so many persons "watching their step" or looking straight ahead rather than up, John F. Cunningham, official of the Crocker National Bank, San Francisco, set a clock—his own patent—covered by four panes of unbreakable glass, in the floor near the entrance of the bank

Sand-Filled Cable Cuts Hard Slate Like Cheese

WIRE saws with teeth of sand grains, whose first use in quarrying rock was reported in the March POPULAR SCIENCE MONTHLY, are now being used to cut huge slabs of slate out of the earth. To show the method the photographs at the right were obtained. Almost as easily as a knife goes through cheese, the endless cable cuts through the slate, making an incision only a quarter of an inch wide.

Large pulleys hold the whizzing steel cable in place on a heavy wooden handle eighteen feet long. As the saw rips its way into the quarry its teeth are fed to it by a sand-bearing stream of water. Small grains of sand are caught up by the braided steel line and help it to eat through the hard slate. Besides doing the same amount of work in less than half the time required by other processes, this new method eliminates virtually all waste. It is also much safer than older methods in which explosives are used to dislodge the rock before it is cut into pieces. Dr. Oliver Bowles of the United States Bureau of Mines, who originated the idea, is experimenting with the new saw in cutting other kinds of rock. If his tests indicate that the wire saw can be used to cut other rocks besides slate—such as marble and limestone, for instance—its general introduction in all mining and quarrying industries will effect great savings.



The wire saw set up for a perpendicular cut into a wall of slate. The steel cable, running as a belt on the two wheels, is pressed against the rock. Passing through the wooden trough it is fed with sand, which serves as teeth, increasing its cutting power. Below: Close-up of saw at work

Know Your Car

THE rear tires on an automobile always wear out before the front tires except in cases where the front wheels are not correctly lined up. This is because the treads of the rear tires stand all the strain of driving the car and, even with four-wheel brakes, most of the braking effort is applied through the rear tires. Many motorists have been in the habit of switching the front tires to the rear wheels when the treads on the rear tires begin to show signs of wear.

Changing the tires in this way undoubtedly increases the total mileage obtainable from a set of tires, but the increase is not much and there is one important disadvantage if you drive at high speeds. A blow-out on a rear tire while going at high speed is bad enough, but a blown-out front tire is far worse, particularly with the large diameter balloon tires now in general use.

Did Balloon Clock Cost Life?

CAPT. HAWTHORNE C. GRAY, Army airman who sacrificed his life in trying to set a world's altitude record in a balloon last November, may have died because of someone's failure to clean his clock, which froze during his flight, Government officials now suggest. Enough oxygen was stored in tanks to keep the balloonist alive in the rarefied atmosphere, but it is believed that Captain Gray, having no accurate knowledge of the passing of time on his descent after reaching an altitude of 42,470 feet, was unable to regulate his use of the canned air to make it properly serve his needs. It was found that two of the tanks were intact, and it is thought that if the clock had not stopped the balloonist would have known when the correct time to open them arrived.

His recording barograph, which was sealed as usual, tells the story of the descent, and shows that it took much longer to come down from the earth's ceiling than would have been expected. Being unaware of this loss of time, officials believe, Captain Gray did not attempt to turn on his reserve supply of air until it was too late to save his life.

Radio Tube Used Backwards Aids Study of High Voltage

OPERATING a radio bulb backwards to reduce high voltages instead of increasing low ones is the latest use discovered for the three-element vacuum tube by Frederick E. Terman, of Leland Stanford, Jr., University, which he recently described to the Institute of Radio Engineers. It enables electrical engineers to study high-voltage alternating currents to better advantage. By this reduction of high tension it is possible to handle electricity with greatly increased safety. No immediate use for the method in ordinary radio receiving sets is foreseen, it is said.

Air Tubes Carry Red-Hot Steel

RED-HOT steel samples are taken from their molds in a roaring steel mill in Berlin and shot through a long tube to the testing laboratory by a blast of compressed air. A thirty-mile-an-hour gale serves to carry the small ingots away from the jarring noises and dusty atmosphere of the factory into the quiet seclusion of the chemists' quarters where, cooled by the swift rush through the tube, the samples are tested with various delicate instruments and with chemicals to see if they come up to standard. The pneumatic tubes are a complete success, according to reports.

Interchangeable Truck Motor

WHEN the driver of the modern horseless milk wagon shown below has engine trouble, all he has to do is call the garage and have a spare motor rushed out. In these new trucks, the motor is geared to the front wheels, so the whole power plant may be replaced in fifteen minutes. Fifteen miles an hour is all the speed required, and the frequent stops do not wear out engine or brake-bands, since a system of transmission similar to the familiar Ford control has been designed for the purpose. This milk wagon does not tire out before reaching the starting point of an outlying route, but if it does stall, the motor may be replaced without transferring the load.

Changing engines in fifteen minutes on motor wagon with power plant geared to front wheels, thus reducing delay when motor fails

Building Bricks Made of Waste From Big Baking Powder Plant

THAT refuse from baking powder manufacture can be used for making building bricks is the remarkable discovery of a great baking powder concern. Mountains of the waste, formerly thrown away, consist principally of calcium sulphate, which is used in large quantities in mixing strong, hard plaster. Since the chemists have found a way of treating the waste and making it serviceable, special machinery has been manufactured to mold it into various sizes of bricks.

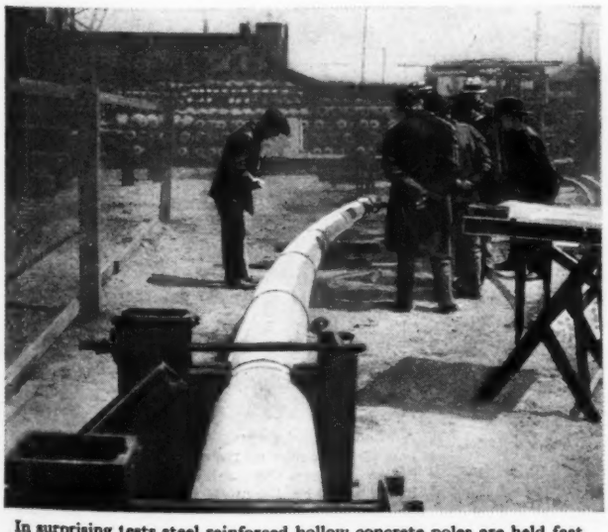
Lumber Dried by Electricity

HEAT produced by electricity is being used to dry lumber in forty-eight hours without damaging the wood in an Oakland, Calif., plant. The weight of the lumber is reduced five percent when the moisture is forced out. Wood is placed in large drying houses and so arranged that the air, blown through heating ovens at the bottom by electric fans, must circulate through the lumber before it can pass out at the top, laden with the evaporated water. The temperature is automatically controlled, starting at ninety degrees F. at the beginning of the forty-eight hours and gradually rising to one hundred and twenty degrees.

Unbreakable Concrete Poles

BENDING concrete poles was the unique feat recently performed in a Milwaukee factory to find how much strain a hollow pole of reinforced concrete would stand. Columns forty-five feet long were fastened at one end and pulled at the other with forces as great as 6400 pounds. Although bent five feet out of line, as shown below, they snapped back to their original straightness without damage when released.

Even sledge-hammer blows while the pole was bent failed to damage it seriously. The columns were made by a "spinning" process, in which a tubular core of steel netting is filled with wet concrete and revolved. Concrete goes to the outside, while water remains in the center and runs out, leaving a hollow core.



In surprising tests steel reinforced hollow concrete poles are held fast at one end and bent five feet out of line, then springing back unbroken

Easy Way to Insulate Home

HOUSE insulation, which means lower fuel cost in winter and cooler interiors in summer, may now be simply and inexpensively brought about by the home owner himself. A depth of two or three inches of fluffy gypsum poured between the joists in the attic, as shown in the photograph above, is all that is needed; and thus the bulk of the estimated sixty percent heat loss through the roof is saved. Only a few bags of gypsum are required for effective insulation.

A simple wooden guide, such as the workman in the picture is using, may be easily constructed from pieces of scrap wood and used to run along the joists to level the gypsum to the desired height.

New Products of Corn Waste

FARMERS are now learning to save such formerly useless stuff as corncobs, husks, stalks, and straw, because the United States Department of Agriculture has discovered a new process of making the waste material into dyestuffs, varnish, and various aromatic chemicals. Lignin is the name given to a substance which chemists say composes twenty to thirty percent of agricultural refuse, and which they are now able to extract. Further research is expected to open up an entirely new field of possibilities, as important relatively, according to Dr. Browne, Assistant Chief of Chemistry and Soils, as that of the coal tar products which yield most of our dyes and perfumes.

Machine Takes Phone Call, Repeats It on Your Return

THE latest automatic telephone device—combining principles of the dictaphone and telephone—was brought to the United States recently by its inventor, J. G. Larsson, a Swedish engineer. Attached to any telephone, it records all incoming messages in its owner's absence, and repeats them to him when he returns.

When the telephone rings, an electrical relay automatically lifts the receiver and sounds a buzzer that notifies the caller the machine is ready. A needle records the message on a roll of specially prepared paper. The owner, upon his return, throws a switch and listens to the reproduction of the record.

Explaining the automatic telephone clerk that takes your message when you are away and, like a dictaphone, repeats it to you when you have returned

How Much Do You Know of the World You Live In?

TEST your knowledge with the questions, selected from many hundreds sent in by readers. Correct answers are given on page 138.

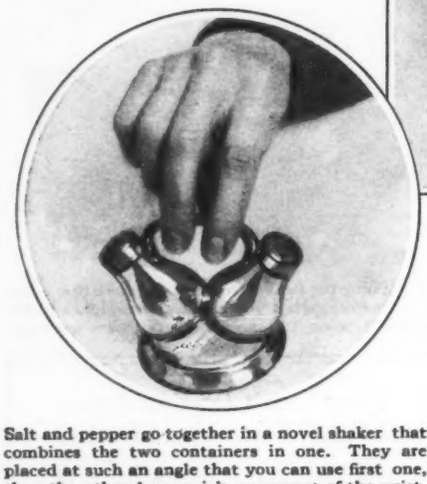
1. Where is the largest tree in the world?
2. Which Mexican city is famous for its beautiful women?
3. Where does mahogany come from?
4. What island is famous for its rum?
5. Where do black diamonds come from?
6. Where do women clean the streets?
7. Which is the oldest town in the United States?
8. How can explorers find food in Arctic ice fields?
9. What lake has neither inlet nor outlet?
10. Where does the tsetse fly flourish?
11. What continent has been damaged by rabbits?
12. What religion predominates in the Holy Land?

New Tools Serve Many Needs

Press the plunger of a new type of salt shaker, and the salt comes out at the bottom. Clogging cannot occur, it is said, even in damp weather; for the action is positive and there are no holes to become obstructed by the damp salt

Beneath a new ironing board swings a capacious hammock that eliminates unsightly baskets and brings the work closer. The fabric of which it is made is readily removable for washing, and can be replaced if desired. An overhead stand keeps the iron cord from tangling or interfering with the pressing. Large and small pieces are handled with equal facility. Dotted lines indicate its capacity

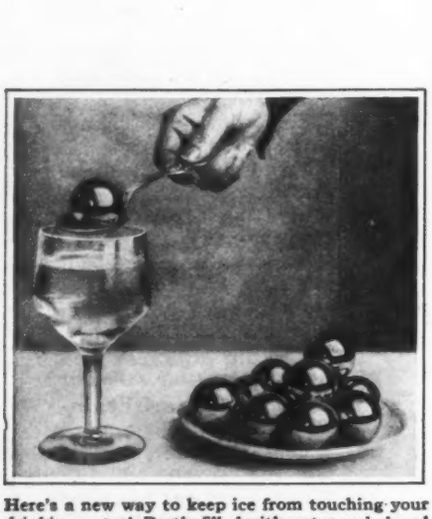
Coffee made in a pressure cook pot has a better flavor, says a French manufacturer, who has devised a unique pressure percolator. Its heavy metal wide-mouthed pot is topped by a tight-fitting, massive lid. Thus, it is said, the most savory part of the coffee is extracted, with a minimum of waste



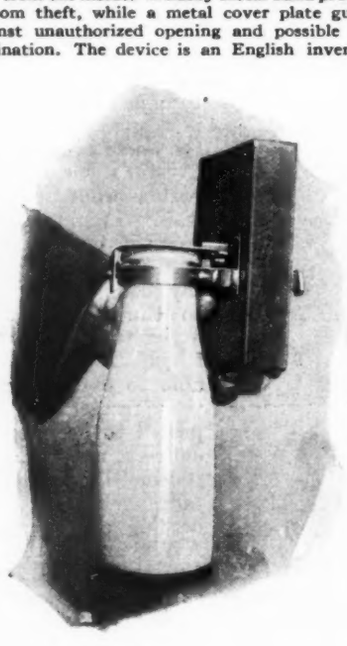
Salt and pepper go together in a novel shaker that combines the two containers in one. They are placed at such an angle that you can use first one, then the other, by a quick movement of the wrist. Moreover, they cannot get separated or mislaid

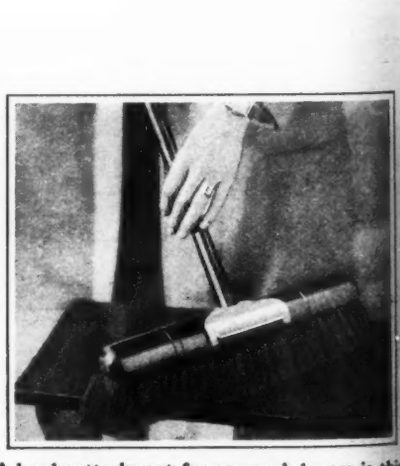
Unusual in that its lid is flat, a new kettle makes a handy stand for keeping coffee warm or cereals ready to serve. The knob is set into the recessed lid, leaving a smooth surface on which to set a percolator or a sauce pan. This feature adds a wide range of usefulness to a kettle's ordinary purposes

After the milkman has placed your bottle in the ingenious new lock-holder below, it can be released only from the inside. A husky metal band protects it from theft, while a metal cover plate guards against unauthorized opening and possible contamination. The device is an English invention



Here's a new way to keep ice from touching your drinking water! Partly filled with water and placed in the chamber of a mechanical refrigerator, these silver-plated balls become floatable, handy pellets of inclosed ice. They chill any drink quickly without diluting it or impairing its purity in any way





A handy attachment for any push broom is this new floor cleaner and scraper. Made of metal, it fits in between the handle of the broom and the brush, being held securely in place when the handle is screwed down. It is the work of only a second to reverse the broom and use the attached scraper, thus combining two useful household tools in one

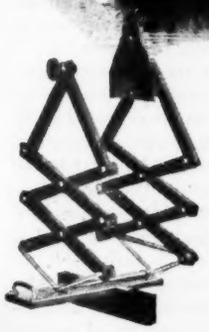
of the Household

Of novel design is this unusual, lightweight aluminum cooking fork, which many a woman will welcome. Its prongs are wide and flattened vertically, making it ideal for mixing salads, mashing potatoes, and a host of other kitchen uses

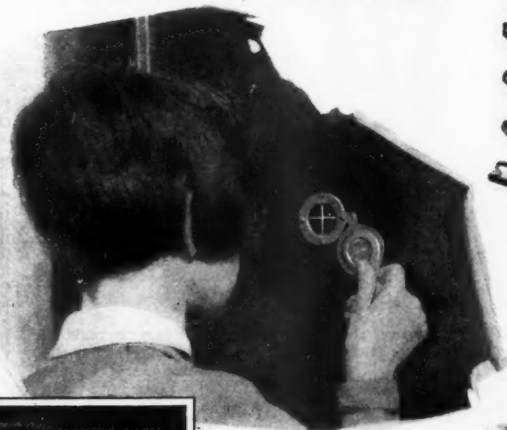
On its side, a new barrel-shaped electric cooker serves as a baking oven, and will accommodate all the fair-sized pans in the kitchen. Its hinged lid easily opens. For stewing or boiling, the cooker stands on end. Legs serve as handles to move it, and the cylindrical shape makes cleaning easy. This handy kitchen device is an English invention

Press this novel coat and hat hanger against the wall—and it stays there. Its suction grip is said to be tight enough to support a heavy overcoat. In Pullman, restaurant, office or automobile, it provides a place anywhere for your coat and hat; and in the kitchen it's handy for an apron that needs a hanger. It folds into small space and can be carried, for traveling, in a vest pocket or a lady's purse

Whether your deep-dish pies contain savory meat or juicy fruit, this new pie cup will hold up the crust while they are baking. Placed in the center of the pan, it also allows any excess steam to escape through holes at its upper end



Raise your window a few inches—move the handle seen at the upper left in the lower picture—and an arm of these new lazy tongs washes the outside of your window. The device takes the hazard out of window-washing and makes it convenient instead; for wherever, on the inside of the pane, you move the handle, the washer will follow it on the outside surface



By combining a convenient turner, usually found only on upright types of toasters, with the speed of the flat-toasting variety, the maker of the new electric device below says he has perfected the last word in toasting apparatus. There is no danger of burning the fingers; a twirl of the knobbed handle turns the toast. The toast cooks faster, it is said, because the heat is under it

You can see out through this ingenious little window for your door—but others can't see in! Its outside is a polished mirror that reflects the blinding outdoor light; within, the surface is plain glass. Two cross lines cut through the mirror permit you to see who is outside

Brand-new is the oven scoop, latest tool for the kitchen, seen at the right. It places hot dishes in the oven, and removes them, without burning the hands; it picks up pans without handles; and, picking up a roast from the roaster, it deposits it upon a platter

An Article Approved by the Popular Science Institute of Standards

Do you have to listen closely for stations you once got with much more volume? You may be able yourself to locate the source of trouble

Making Your Radio Speak Up

How to Go Over Your Receiving Equipment from One End to the Other, Find the Cause of Weakness, and Apply the Remedy

By Alfred P. Lane

FINDING out what's wrong with a radio receiver when it goes completely dead is usually much easier than locating the trouble when the set continues to operate but gives generally weak and unsatisfactory results.

This state of affairs has been encountered many times during the course of the testing and research work constantly being carried on in the radio laboratory of the Popular Science Institute of Standards. Of course, the complete testing equipment available at the laboratory makes it an easy matter to discover what's wrong with a radio set, no matter how involved or deep-seated the trouble may be. But the owner of a radio receiver that no longer gives good results is not so favorably situated.

If your radio receiver, for example, brings in the stations weakly and otherwise fails to live up to the standard of performance of which it was capable when new, your first thought is that the batteries may be getting weak. And the chances are that you will have guessed right. You may find, however, that replacing the B-batteries effects no noticeable improvement. The next logical place to look for trouble is in the tubes. Even though they light as brightly as ever, the active material on the filaments may have become exhausted so that one or more of the tubes may have ceased to function.

BUT what do you do if your dealer's tests show that the tubes are all right?

The logical way to go at the problem of finding out what's wrong after you have definitely proved that it is neither weak batteries nor exhausted tubes is to start at the antenna and follow the path the signal takes to your radio receiver.

Of course many things can be wrong with your radio antenna, but tests at the Institute of Standards show that only two of them can cause weak volume without also producing accompanying noises.

One of these is dirty insulators. Dirt on the antenna is of no particular importance, but if the insulators, through long continued exposure, become coated with a layer of sooty grime, a sufficient amount of current will leak through the soot to cause an appreciable falling off in signal strength, especially on stations that are not received with any great amount of volume even under the best conditions.

Removing the grid leak sometimes reveals a defective grid condenser, and it may prove that the leak also is no longer functioning as it should

Five Causes of Weak Signals

Dirty antenna insulators, dirty lightning arrester, poor antenna and ground connections.
Remedy: Clean insulators, repair connections, replace arrester.

Short circuits or open circuits in radio stages.
Remedy: Find the short and remove it, locate the break and repair it.

Leaking grid condensers and grid leaks that don't leak.
Remedy: Replace the defective part.

Partly shorted audio transformers.
Remedy: Replace with better grade instruments to improve tone quality.

Weak loudspeaker magnets or partly shorted windings.
Remedy: Send the unit back to the manufacturer.

NATURALLY, the effect of soot and grime depends entirely on the thickness of the layer and the nature of the material that is in the deposit. If you live in the country far from any industrial center, your antenna insulators may not become coated with an appreciable deposit even after two or three years. On the other hand, if you live in a region where soft coal is the principal fuel, a noticeable deposit of soft coal soot may settle on the insulators, and soft coal soot is a relatively good conductor of radio-frequency current.

The amount of current leakage over the dirty surface of an antenna insulator naturally is much greater in damp weather.

The other antenna trouble is a corroded contact between the antenna and lead-in. In the majority of cases a corroded contact at this point results in reception marred by scratching and grating noises, but occasionally, as shown by tests in the Institute of Standards laboratory, the corrosion will occur in such a way that the resistance of the joint will rise to a very high and yet constant value. The result is a decreased flow of current not accompanied by any extraneous noises.

Obviously, the remedy for dirty insulators is to clean them; and the cure for a bad joint is to make a new one or to resolder the old one after cleaning it thoroughly.

After you are positive that the antenna is in good condition, check up on the lightning arrester. Often it is the unsuspected cause of poor signals. In this case, also, the trouble is due to dirt. The most common type of lightning arrester consists of a small pair of metal plates set close together and sealed in place. The outside surface of the arrester can become covered with soot just as can the antenna insulators. In addition, the plates may become partly short-circuited by the metallic dust driven off the plates by the sparks of lightning discharges. Determining whether the lightning arrester is responsible for weak signals is easy. Merely remove the wires from it and see if the signal strength is improved. If the signals are noticeably better without the arrester, replace it with a new one.

The ground connection of the radio receiver can become corroded in the same way as the antenna lead-in, and the remedy is the same.

Assuming that your antenna, lightning arrester, and ground connections are all right, and that your tubes and batteries are in perfect condition, the next step in locating the cause of weak signals is to determine whether the trouble is in the radio-frequency stages, the detector stage, or the audio amplifier stages.

THE manner in which the radio-frequency stages tune often will give you a clue as to what is wrong. If any particular stage seems to tune much sharper than the others—sharper, in fact, than it did when the set was new—there probably is a broken connection in the wiring of that particular stage. However, you need not bother to check the connections of the coil to the condenser terminals. The fact that the stage tunes sharply is sure proof that these connections, at least, are all right.

But if one stage tunes very broadly, look at once for a short circuit. Perhaps it is one of the turns in the tuning coil, possibly the socket has become shorted in some manner.

The effect of a short-circuited turn in a tuning inductance is very serious. A radio receiver just recently arrived at the Institute of Standards for testing. As usual, the set was first hooked up on the test bench to make sure that it was in operating condition. This test always precedes the most elaborate tests which are made to determine the sensitiveness, selectivity, and tone quality of the receiver. In this preliminary test the receiver performed poorly. The first dial tuned very broadly, much more broadly than it should have, even taking into account the broadening effect of the antenna coupling. All the apparatus in the first radio stage was immediately examined, and it was found that in the soldering of wire onto a tap on the secondary coil of the first stage, a tiny tip of solder had formed on the joint and pressed against the insulation on the next turn. The jars and bumps received by the set during shipment had served to force the sharp tip of solder through the insulation, thus short-circuiting just one turn of wire. The sliver of solder was flipped off with a pin point and the receiver functioned in the proper manner!

"Pinging" the detector tube with your finger nail should result in a loud ringing sound from the loudspeaker. If not, either the detector tube is dead or something is wrong with the audio amplifier

Touching the grid end of the grid leak or tapping the glass of the detector tube with your finger nail should result in a howl or a ringing sound from the loudspeaker, and if a good loud noise can be produced in either of these two ways you may be pretty sure that there is nothing radically wrong with the audio amplifier end of the receiver.

IF THE connections to the tuning unit on the detector circuit are all right, and you are sure that the tube is a good one, the most likely place to find trouble in the detector circuit is in either the grid leak or in the grid condenser. Removing the grid leak should make a noticeable difference in the volume. If it doesn't, suspect the grid condenser, unless you are using one of the special detector tubes, in which case the grid leak may or may not improve reception. With a 201A tube, however, removing the grid leak should result in a noticeable falling off in volume, unless the grid condenser is partly short-circuited so that it is leaking current.

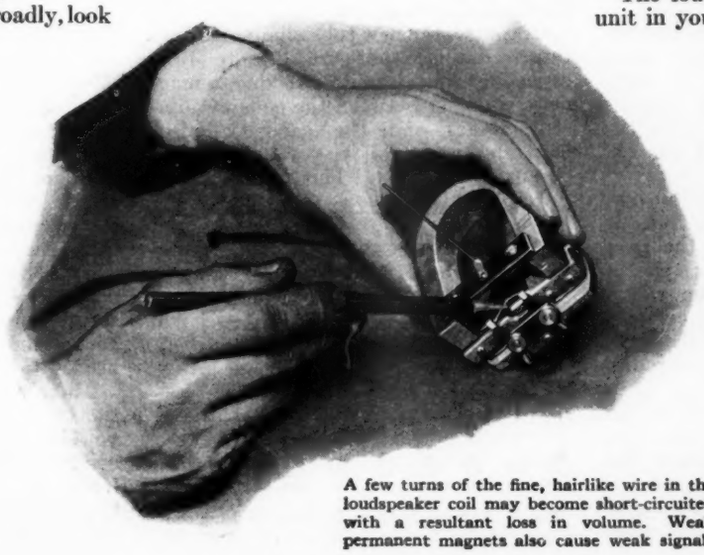
On loud signals, removing the grid leak should result in a falling off in volume combined with a choking effect due to the blocking of the tube. So if your set acts in this way with the grid leak in place, you may be sure that the grid leak is practically out of commission. When grid leaks go bad, the resistance goes to a very high value, sometimes as much as five or ten times as high as the rated value. This extremely high resistance is, on strong signals, almost as bad as no grid leak at all. There is no way to repair a defective grid condenser or grid leak. The only remedy is new parts.

AS FAR as the audio amplifier itself is concerned, the experience of the Institute of Standards has been that, aside from tubes going bad, not much can happen to a transformer coupled amplifier that will result in generally weak volume. Either the amplifier works at full efficiency, or a broken connection puts it entirely out of commission. Once in a great while we encounter a transformer that gives weak signals due to short-circuited turns in either the primary or secondary windings.

Resistance coupled and impedance coupled amplifiers occasionally give poor volume due to a fixed resistance that goes bad. This is particularly true of resistance coupled amplifiers where the value of the resistance is of great importance. If the plate resistances—like the grid resistances mentioned above—become defective, and the resistance goes way higher than it should be, the volume will decrease to a noticeable degree.

The loudspeaker is, perhaps, the last unit in your radio equipment to suspect when the volume falls off. Like the audio transformers in your set, the loudspeaker usually operates at full volume unless something goes wrong and the winding burns out. Sometimes, however, a few turns in the loudspeaker winding become short-circuited, and the result is weak signals. Another somewhat rare trouble is to have the permanent magnet weaken.

The simplest test for a defective loudspeaker is to try your neighbor's speaker instead of your own. If his sounds right and yours doesn't, there is no question about the condition of your loudspeaker.



A few turns of the fine, hairlike wire in the loudspeaker coil may become short-circuited with a resultant loss in volume. Weak permanent magnets also cause weak signals

Amazing New Amplifying Tube

Popular Science Institute of Standards' Tests Show Greater Distance and Volume with "Screen Grid" Type Now Available

By JOHN CARR

Laboratory Staff, Popular Science Institute of Standards

PUTTING another electrode into the vacuum tube has produced astonishing results. What was considered excellent performance in the way of radio-frequency amplification may soon be considered too trifling to bother with, for the new Type 222 four-electrode vacuum tube opens up possibilities for radio-frequency amplification formerly considered unattainable.

Preliminary tests in the radio laboratory of the Popular Science Institute of Standards show that the great stumbling block in the way of high radio-frequency amplification, the internal capacity of the elements in the tube, has been practically eliminated by the construction of the new tube.

Testing the inter-electrode capacity of the new screen grid vacuum tubes in the Popular Science Institute of Standards radio laboratory. The table is covered with sheet copper to eliminate stray capacity effects

This internal capacity has been the limiting factor in spite of all attempts to overcome it. Of course, the various methods that have been worked out to minimize the effect of tube capacity have resulted in far greater efficiency than otherwise would be possible. Balancing according to the neutrodyne method and

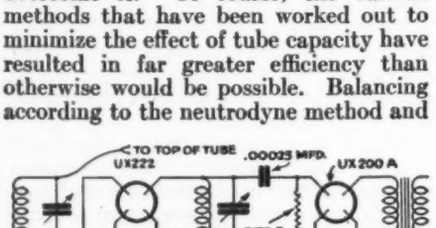


Fig. 2. The fundamental circuit for the screen grid tube, using one stage of radio-frequency

earlier systems such as potentiometer control, grid resistances, variable plate voltage and so on, have given us really fine radio receivers, but all these methods may be swept into the discard when the full possibilities of the new Type 222 tube have been worked out.

The Type 222 tube is designed for use in battery-operated receivers, but it seems logical to believe that the near future will see a corresponding type of tube developed for use in the radio-frequency stages of alternating current-operated electric sets in place of the Type 226 or Type 227 tubes now used as radio-frequency amplifiers.

The secret of the new so-called "screen grid" four-electrode vacuum tube lies in the wire screen that surrounds the plate. A diagram of the internal construction is shown in Fig. 1. The screen grid is connected to the base prong that makes contact with the grid terminal in the standard type socket, whereas the actual control grid is connected to a terminal mounted on the top of the tube. This top-connected grid is wired to the tuning circuit and the screen grid, or in other words, the grid terminal of the socket is wired to the forty-five-volt terminal of the B-current supply. The normal plate voltage is raised to between ninety and 135, and the control grid (the top connection) is given a 1.5-volt negative bias.

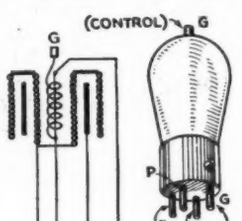


Fig. 1. How the new tube is constructed. The wire screen shields the plate

Because the plate current does not vary to any appreciable degree with changes in plate voltage, it is desirable to use a very high resistance or impedance in the plate circuit in order to obtain high voltage amplification.

Of course, the new tube eliminates only those troubles that are due to tube capacity. Squeals and howls due to magnetic coupling between the coils of adjacent stages and the capacity effect between portions of the wiring still must be guarded against. This means that if you use more than one stage of radio-frequency amplification, it is absolutely necessary to resort to complete shielding—the shielding arrangement, for instance, used in the Popular Science Electric Set. When an alternating current type of the new shielded grid tube is developed, the Institute of Standards radio laboratory will work out the necessary changes in the wiring to permit the tube to be used in the electric set.

Fig. 2 shows the fundamental circuit for a single stage of radio-frequency amplification using the new shielded grid tube, and Fig. 3 shows how the tube may be used in the four-tube receiver of POPULAR SCIENCE MONTHLY Blueprint 43. It can be used in the five-tube set of Blueprints 54 and 55 in much the same way. In each case the balancing condenser is discarded, the detector secondary coil and condenser are used as a tuned impedance in the plate circuit, and the coil C—previously used as the radio-frequency transformer primary—is now used as a tickler coil with capacity feedback. In the five-tube hook-up above mentioned, the primary coil is not used, as there is a separate tickler.

Great care must be used in the setting of the coils. The new tube should give greatly increased radio-frequency amplification, which means more distant stations and more volume on the ones you now hear. There is, however, a decrease in selectivity.

Picture diagrams showing these changes are not available, and consequently we do not recommend that you experiment with the new tube unless you have had some experience in radio work.

You will note in these diagrams that a ten-ohm resistance is connected into the screen grid filament lead in addition to the regular rheostat. This is needed because the new tube is designed to operate at 3.3 volts on the filament with a filament current of .132 amperes. By using a separate resistance you can use the drop across the resistance to give you the needed C-bias.

Make sure that you change the connections to the grid leak as indicated, for if you leave it connected across the grid condenser the plate voltage of the radio-frequency amplifier tube will be applied to the grid of the detector tube and the circuit will be inoperative.

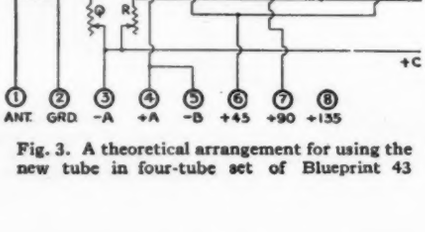


Fig. 3. A theoretical arrangement for using the new tube in four-tube set of Blueprint 43

He Built a Home in Odd Time

Neighbors Helped, but the Job Was Ralph Elliott's, and His Story Shows What an Amateur Builder Can Do

By JOHN R. McMAHON

This is the second of Mr. McMahon's articles about real houses built and remade by real people, articles of intense interest and inestimable value to everyone who has or expects to have a house. Perhaps you know a story as interesting—your own or some friend's. Write about it to the Homebuilding Department, Popular Science Monthly, 250 Fourth Avenue, New York City.

Elliott and Philip Crane (with the pick), one of his neighbors, beginning the task of building a home by digging cellar with pick and shovel

"HERE'S a joke in the paper, fellows," announced a fleshy man to a group of friends. "The headline says, 'Anybody Can Build a House in His Spare Time.' Ha! ha!" His cronies joined in his laughter.

"It's funny all right," remarked one, charging his briar pipe. "Just how much spare time does 'anybody' have? In winter we get home in the dark. In summer we have about enough daylight to manicure the lawn and tinker the car."

"Taking a Sunday ride and growing a couple of vegetables uses all my spare time," said a spectacled third as he thumbed a deck of cards. "Say, we need another hand to start this game. Who can we get?"

"Elliott," suggested the pipe smoker, calling to a near-by man.

The slight, boyish looking man looked up from the pad on which he was penciling mathematical lines and shook his head. The card players urged him to quit his puzzle and join in a real game. Invited insistently, he explained:

"Boys, I'm planning to build a house in my spare time and I am busy figuring now. Otherwise I'd be glad to join you."

The dumbfounded group recovered by degrees. "If you don't mind telling us," inquired the stout man, "when did you learn how to build a house?"

"I NEVER did," was the frank reply. "I expect to find out as I go along. You see, it's my notion that anybody can do almost anything if he will take hold and begin. A house is only pieces of wood, masonry and other things put together. Why can't anyone put 'em together? I can!"

"By George," muttered the spectacled one as he shuffled the cards. "If I had a dose of his brand of New Thought or whatever it is, I'd be a transpolar air pilot."

All this was about a year ago. The other day I visited the dwelling built in time squeezed out of week-ends and summer evenings. It is neat and cosy, picturesquely located on the bank of a small river in Teaneck, N. J., a suburb of New York City. Colonial brownstone habitations contrast with the smart new homes of a suburban development there. The self-made Elliott house ranks between its more pretentious neighbors and the Colonial relics. It is modest wood frame, but it embodies comforts and luxuries that were beyond the dreams of the Colonial lords of the manor.

Ralph H. Elliott, a Teaneck, N. J., shoe man, and his son in the home he built in spare time with the help of neighbors, all as inexperienced as himself. The fireplace is of concrete, lined with firebrick, and painted to resemble brick

Ralph H. Elliott is not the type you expect to find in an amateur home builder. For all his self-confidence he is quiet and shy. He is frank and obliging by nature, popular with the neighborhood boys to whom he is an authority on hunting, fishing and trapping. After meeting him, you don't wonder why several grown-up neighbors volunteered assistance on his home enterprise.

"I was born on a farm in Connecticut," he told me. "That farm, where I stayed until I was fifteen, was my school of architecture, building, tinkering and the rest; we used to do everything on the place. Then I went into a shoe factory as a machine hand and stayed six years. Next I moved to the city and took a job in the wholesale shoe business that I held for twenty-three years.

"WE BOUGHT a ready built house in this town, and after ten years sold it and cleared $2,000. We borrowed $3,500 and went in debt for $1,000 more. We'd bought this site, paying $5 a month, for $600. It's worth a good many times that now and the whole place is now worth about twice all it cost us."

"How did you make the plans?" I asked.

"My wife and I talked over what we wanted," replied Elliott. "We had a boy and a girl. We needed three downstairs rooms, four bedrooms and a bath. I took an ordinary ruler and drew the plans in pencil on a scale of a quarter inch to a foot. Anybody can do that. A neighbor inked them for me and had blueprints made."

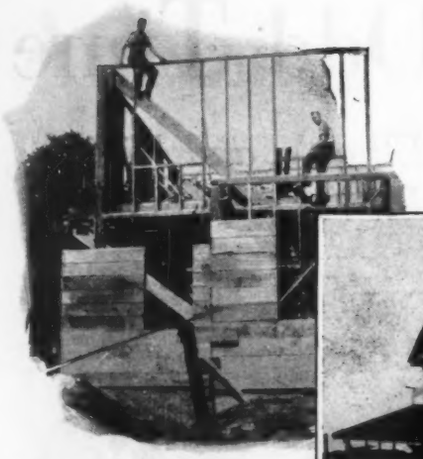
"OTHER neighbors gave you a hand, I believe."

"Yes, they certainly did. They all turned out Sundays and holidays. There were three principal helpers, including a relative. One was a house painter. None of us was any kind of builder. Perhaps we should have been stumped but we weren't. We argued a little, sometimes took a look at the method being used in a near-by building, then went ahead."

"Did you plan to build a complete cellar?" I asked.

"I did because it is a protection to health, makes the house warm, tends to save woodwork from decay and gives a lot of useful space. My cellar is twenty-four by thirty-six feet, even extending under the glassed-in front porch, which is eight feet wide. It is five feet below outside grade and the head room inside is seven feet six inches. The headroom is often skimped in cellars so that the owner either gets stoop-shouldered or the cellar is only half used."

"How was the excavation done?"



Closing in the second floor three months after excavation began. Studs were sheathed with shiplap; Western red cedar clapboards and shingles were used for finishing

Five months after the start the roof is completed, including the asphalt shingles. A month later the owner and his family were occupying the finished structure

Building the forms for the concrete foundation walls. After this month's job the mixture—one part cement, two parts sand and four parts cinders—was made and poured in a single day

"All with pick and shovel, and it was hard clay," replied Elliott. "The neighbors and I had plenty of exercise. The next time I would use a caterpillar tractor scoop. We began digging in late March and it took about a month. Almost another month was needed to set up the wooden forms for concrete foundation walls. These were to be eight inches thick and to extend two and a half feet above grade. On May 23 we poured the forms, completing the job in one day."

"It is good practice to finish any concrete work in one day," I remarked. "Of course you must have had a machine mixer."

"No," was the unexpected reply. "Ten men—volunteers and some of them not at it steadily—did all the work by hand between 7 A.M. and 7:30 P.M. All the materials were conveniently placed and there were three mixing boards strategically located, each with its water hose, so there were no lost motions. The mixture we used was one part cement, two parts sand and four parts cinders. The latter are lighter than stone or gravel and therefore a little easier to handle."

"HOW has the cinder concrete stood up in your cellar?"

"It has kept out water so far, but I attribute this largely to the tile drains which were laid first under the floor. Cinder concrete is more porous than a stone mixture. It can be absolutely waterproofed by plastering on both sides with a rich mixture of cement and sand. It is also claimed that in upper walls the porosity of cinder concrete makes for dryness and insulation."

Elliott agreed with me that the choice of ingredients depends on circumstances. For a wet site a dense stone concrete obviates the expense and labor of plastering. Some cinders may contain injurious chemicals, and too much porosity may permit such insects as white ants to pass through and attack woodwork.

"I made the ceiling height on the first floor eight feet ten inches and on the second floor eight feet six inches," said Elliott. "Next time I would make them all around eight feet. This way it is warmer in winter and just as comfortable in summer, at least in a northern climate. The pioneer dwellings had such low ceilings that tall occupants would almost bump their heads against them; the modern reaction from that idea has been nine-foot ceilings. That is too much. If you save a foot and a half of material on two floors, you are in a considerable number of dollars."

"What kind of framing did you use?"

"There is a four-by-eight-inch sill on the foundation walls, made of two two-by-eight-inch spruce planks spiked together. A girder is similarly built up of three two-by-eight-inch spruce. It is stronger than one solid timber because knots are distributed, and costs less and is more easily handled. I put three iron columns under that girder, perhaps one more than was strictly necessary. The first floor beams are the same size and kind of planks used in sill and girder, spaced on sixteen-inch centers and with bridging or X-shape braces every eight feet. The second floor beams are similar except that the wood happens to be hemlock, which is now going out of the market. The corner posts of the house are doubled two-by-four-inch studs, while the studs between are spaced at the regulation distance of sixteen inches."

"What about frame bracing and fire-stopping?" I asked.

"The first did not seem necessary," replied Elliott. "By way of fire-stopping, I ran subfloors through to sheathing and then spiked two-by-four-inch pieces on top and between studs. This will keep fire, not to mention cold and vermin, from going up partition spaces between floors. Of course, I framed all door and window openings with doubled two-by-fours.

"IN fact, I was generous with this size lumber, trying to prepare for the job of lath-and-plaster, and would know how to save some of the material if I had it to do over. All the flooring is laid at right angles to beams. Diagonal subflooring and wall sheathing are stronger, but take more labor and material."

"How did you complete the walls?"

"I sheathed studs with one-by-ten-inch shiplap, then applied building paper and over that six-inch clapboards of western red cedar for the first story and wood shingles above. On the inside I put on wood lath for plaster. The plasterer charged $180 for his labor with the cost of material extra. A single coat was applied, but it is three quarters of an inch thick and seems to be all right."

"The amateur builder," I observed, "is often stumped by the problem of roof angles."

"Luckily, my painter neighbor knew how to use a steel square so as to get the angles of the rafter cuts," said Elliott. "The square also gave us the method for sawing the stringpieces for stairs. There is a wealth of useful information in those figures on a carpenter's square, and everybody who uses tools should learn how to apply it. The rafters are two by six-inch on sixteen-inch centers, sheathed with shiplap boards. There are asphalt shingles on top.

The owner and his house at its completion after six months' work by himself and neighbors on Sundays, holidays and summer evenings

"THE plumbing I let out to outside men at a cost around $535, but the heating system was strictly home work. I built the chimney and fireplace of cinder concrete poured in a form around two sets of flue lining. The fireplace, painted to resemble brick, contains a home-made iron damper. The top of the fireplace opening is so thick that no metal reinforcement was required. There is a lining of firebrick for the inside of the fireplace and (*Continued on page 140*)

Giant, freight-hauling locomotive with auxiliary locomotive underneath the tender equipped with SKF Spherical Journal Bearings on all twelve wheels.

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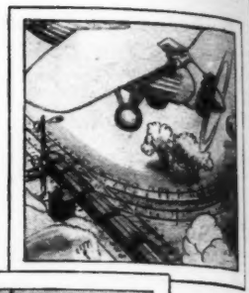
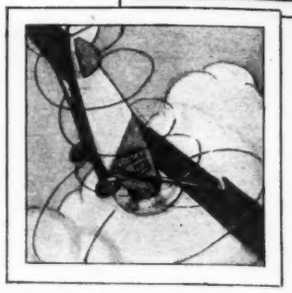
Above: Doing an "Immelmann." Plane is half-looped onto its back and "half-rolled" to upright position. Below: A "zoom"—a brief steep climb

Aviation Slang

The "Kiwi," the "Pay-Hop," the "Washout," the "Chinese Landing" and Hundreds of Other Terms Translated Here

By
BROCK MAYS





Above: "Hitting an open switch"—following the wrong railroad line as a guide. Below: In a "stall" the nose of the plane drops and a spin may result

"THAT kiwi was up on a payhop; he put her on hot down-wind and washed out the only peppy crate in the outfit. He's a Chinese ace."

Aviation has a language of its own and that's a sample. A greenhorn may well wonder what it's all about. Many aviation terms are now found in the dictionaries, while others are as yet strictly slang.

A "kiwi" is a "groundhog" or pilot who does not like to fly. This expression is derived from the New Zealand kiwi or apteryx, a bird that cannot leave the ground. In contrast an "airhog" loves to fly at every opportunity, being anxious to "pile up time." A "payhop" is a flight made by an Army or Navy pilot to meet the requirements which entitle him to "flight pay." A "joyhop" is a flight for pleasure. To "put her on hot" is to land fast, usually resulting in "overshooting" the field and sometimes running into obstructions at the end of it. A "down-wind" landing is made with the wind on the tail, which greatly increases the speed over the ground with resultant increased danger of accident. It is correct to land only "up-wind," or into the wind.

A "cross-wind" landing is sometimes necessary in a restricted field, the plane being "skidded" into or towards the wind to counteract the "drift" or side-strain as the wheels touch.

"CHINESE landing" and "Chinese ace" are derived from the Oriental flavor of the words "one wing low." Damage to a plane is spoken of as a "crack-up" or "crash" and if beyond repair as a "washout."

A "peppy crate" is a plane in excellent condition that flies well. A "loggy" ship is a heavy, overloaded or old plane that flies and handles sluggishly. An airplane is always "she."

A "night bomber" is a pilot who likes to sleep in daytime and visit night clubs and festive gatherings at night. A "big-boat pilot," strictly speaking, is one who has specialized in flying big-boat seaplanes; colloquially a "big-boat pilot" is just a good sport, akin to the big butter and egg man. A "dizzy" pilot is one who is always taking chances, "hedge-hopping," flying "nose-down and over the tree tops," stunting "off the ground" (low) and the like. A "sweet" pilot is a good one; so is an "ace."

A "night bomber" is a pilot who likes to sleep in the daytime and make merry at night in cabarets and dances and other festive social gatherings

A "zoom" is a brief, steep climb. The "floor" is not the ground; it is the "ceiling" or highest altitude to which a plane will climb. "I had her on the floor" means she would not climb any higher. To "hit an open switch" on cross-country flying is to follow the wrong branch of a railroad.

The propeller is the "prop," and the "slipstream" is the air blast blown backwards by the "prop." A "caterpillar" is a member of the Caterpillar Club, open only to those who have saved their lives by using a "chute" (parachute).

A nervous pilot is said to fly "with both hands on the stick" or to "fight the controls" or to fly "with his head in the cockpit," i. e., watching the instruments continually. He is also "air-blind." One that does not like close formation flying is "hard to get close to." "No plane will ever drop out from under him" indicates a pilot who flies and glides fast (well above stalling speed) and therefore often "overshoots"; it may be said that such a pilot "cannot fly a kite."

IN A "stall" the nose drops and the plane usually whips into a "spin" (also called "tail-spin"; incorrectly called "nose-spin" or "spinning nosedive"). In a "tail-spin" the nose is pointed down and the wings revolve around the axis of the fuselage, which is nearly vertical. Failing to recover from a spin before striking the ground is called "spinning-in."

An erratic pilot frequently has "pilot trouble," though he may blame his engine or plane. "He just went for the ride" distinguishes a passenger from a pilot; this phrase is borrowed from the race track, where it applies to jockeys who do not try to win. In a "side-slip" the plane is thrown on its side and dropped vertically downward along the lateral axis. After "leveling off" for a landing, excess speed may be killed by "fish-tailing"; that is, skidding the ship violently to either side and then kicking it around straight again.

A "ground-loop" consists of turning a plane in a small circle on the ground; it is used after landing to avoid over-running a small field. In "three-point"

(*Continued on page 141*)

Left: "Chinese three-point landing," developed from the Oriental sound of "one wing low." Three points are propeller hub, wing tip and wheel. Right: "Three-point landing"—on wheels and tail skid

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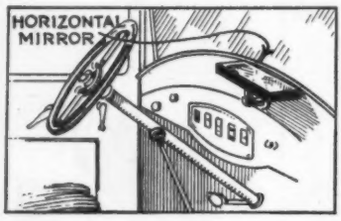
Helpful Hints for Motorists

Mirror Keeps Traffic Lights in View—Tool Compartment That Locks—Handy Spouted Can—Light Tells When Brake Is On



Traffic Light Mirror

THE combination of high-swung traffic lights and low closed car tops has resulted in a difficult problem for the motorist. When you pull up to the indicated white line on the pavement because the red "stop" light is on, you usually find that you can no longer see the light without bending forward and squinting upward. Sometimes, of course, you can watch the traffic light a few blocks farther on, and occasionally you can keep tabs on them by watching the light two or three blocks behind you by means of your rear vision mirror. A simple way to eliminate the need for bending forward and looking upward is shown in Fig. 1. Any standard type of rear vision mirror can be mounted at any convenient point on the dash and so adjusted that it will reflect to your eyes the traffic light you find it necessary to watch.

Fig. 1. In order to avoid squinting under the sunshade to determine when the traffic light changes, mount a mirror as illustrated in the drawing at the left

Ten Dollars for an Idea!

JOHN ODILL, of Norway, Mich., wins the $10 prize this month with his suggestion for a brake position indicator (Fig. 4). POPULAR SCIENCE MONTHLY awards $10 each month, in addition to regular space rates, for the best suggestion sent in for motorists. Other contributions published are paid for at the usual rates.

A Locked Tool Compartment

WHILE many motorists have no scruples about borrowing tools from a near-by car if the tools are not locked up, relatively few auto owners will break open a lock to get at the tools. Therefore, any kind of lock is better than leaving the tool compartment without any protection. The drawing in Fig. 2 shows a simple tool compartment built into the door. The usual fabric, cardboard or veneer covering on the inside of the door is removed and replaced with a sheet of galvanized sheet steel with a door fitted into it. Loops of leather are arranged to hold the tools that you are most likely to need in a hurry. The hinges of the door should be held in place with rivets, and if carefully fitted and equipped with a good lock it will resist the efforts of any but a determined crook.

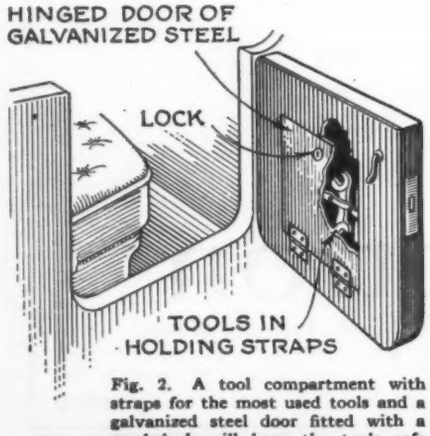


Fig. 2. A tool compartment with straps for the most used tools and a galvanized steel door fitted with a good lock will keep the tools safe

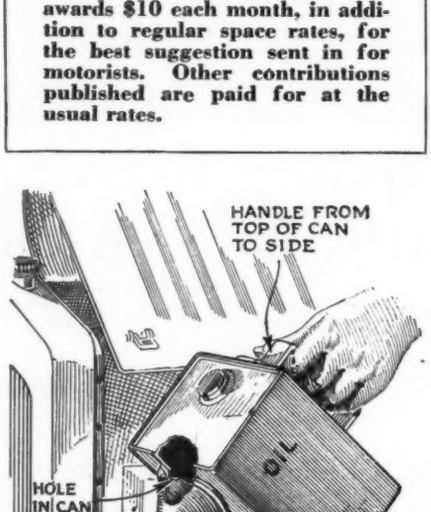


Fig. 3. An old oil or varnish can is easily fitted with a spout made of a funnel. It will prove a timesaver and save spilling when adding oil to crank case

Handy Spouted Can

POURING oil or any other liquid from a large can without spilling is extremely difficult, especially when the can is nearly full. Then, too, a funnel that stands around the home garage catches a lot of grit and dust that is carried into the motor crank case each time the funnel is used. Fig. 3 shows how to arrange a large oil can to eliminate these troubles. A hole is cut in the side with a can opener and a small funnel is soldered in place over the hole. The handle on the top of the can is unsoldered and resoldered in place on the side of the can opposite the funnel, making pouring of oil easy.

Light Shows Brake Position

IT IS safe to say that practically every driver of an automobile occasionally attempts to start his car with the emergency brake set. Ordinarily, the driver notices something is wrong at once and so no damage is done, but there have been many cases where propeller or axle shafts have been snapped off or transmission gears seriously damaged. And there are many otherwise excellent drivers who never seem to get over the habit of forgetting to release the emergency brake. Fig. 4 shows a novel way to prevent this trouble. A special lamp automatically indicates when the emergency brake is on, but it lights only if the ignition also is turned on, and therefore does not stay lit when you leave the car with the emergency brake set.

An excellent lamp for this purpose would be one of the red or green jeweled indicating lights sold for use on the panels of radio receivers. Another simple arrangement would be an ordinary flush type socket with a two-candlepower bulb, colored red or green. The wiring diagram for this indicator is shown below.

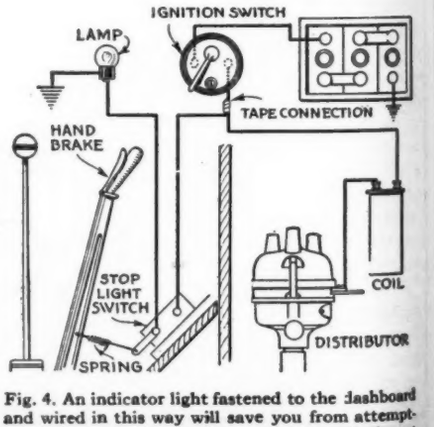
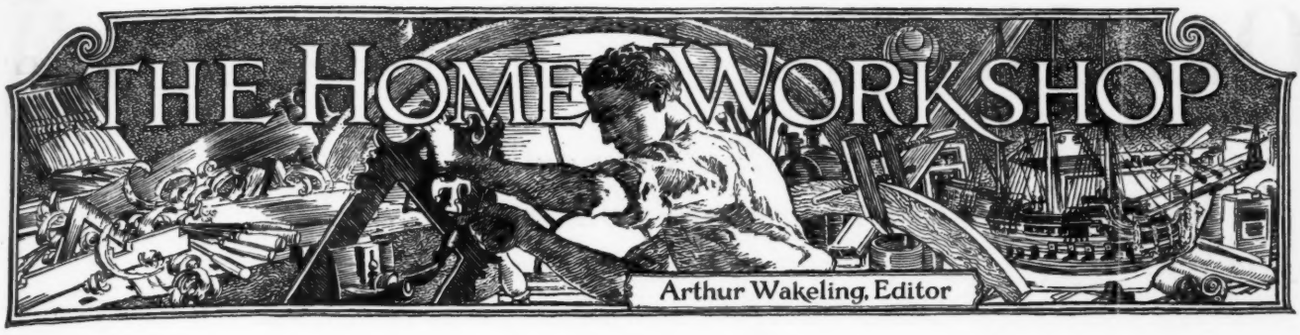


Fig. 4. An indicator light fastened to the dashboard and wired in this way will save you from attempting to start the car with the emergency brake set



Painting with Hand Sprayers

A Brushless Method for Home Use—How to Treat Both Flat and Uneven Surfaces—Novelty Effects

By Berton Elliot

"I'M SO glad you came over, for there's something I've wanted to ask you for a long time," exclaimed Mrs. Andrews, our neighbor, the other evening when my wife and I dropped in to see what she had been doing lately in the way of painting and decorating, which was her hobby. Like so many home workers, both men and women, she had discovered the fascination, not to say economy, there is in doing one's own painting and decorating. She had found many opportunities for practice in her large house and had become unusually expert.

"It seems like old times to hear you say you have a question to ask," I responded, for Mrs. Andrews had been one of my "pupils" when the painting of furniture first became popular as a home craft a few years ago.

"It's about those hand sprayers for applying lacquer that they're selling at the stores now," she continued. "Are they fully successful?"

Mr. Elliot shows Mrs. Andrews the correct position for holding the paint sprayer when lacquering a flat and relatively large surface such as a table top

"ABSOLUTELY," I assured her. "They will do good work for anyone who will take thirty minutes to experiment and practice before starting to paint the first piece of furniture. Manufacturers have been working steadily on the development of hand sprayers for use with lacquer, enamel, paint and varnish. Sprayers have been developed to a point where they give a finer spray, more uniform distribution and a much more continuous stream than garden hand sprayers, which some home decorators have been using. One of the greatest advantages of the hand sprayer is, of course, the efficiency and ease with which it reaches hard-to-get-at and uneven surfaces, such as wicker ware, reed and fiber furniture, radiators and objects with ornamental carvings or fancy turnings."

"They are not hard to use, then?" interrupted Mrs. Andrews.

"If you'll wait a minute, I'll go home and get one I've been experimenting with," I said, "then I can show you as I go along."

When I had brought the sprayer over and we had spread out newspapers to make ready for the demonstration, I poured some lacquer into the reservoir.

"Put in about as much as it will take to do the job," I explained, "for you can keep spraying until practically the last drop is used. Be sure, however, you have enough, so you will not run short. Regular brushing lacquer is generally used, but it should be thinned with lacquer thinner of the same manufacture as the lacquer. Use from twenty to thirty-three and a third percent of thinner; it depends upon how thick is the brand of lacquer you are using. Enamel and enamel undercoaters should be thinned with turpentine to a spraying consistency. Then adjust the spray nozzle as explained on the direction sheet for the particular make of sprayer you are using. Pump a few strokes against an upright try-out surface. Here's where your experimental work comes in. Keep adjusting the nozzle and pumping a stroke or two until you get the spray just right. Practice until you get the knack of it and can keep a steady spray coming continuously. And, by the way, never commence working on an article without taking two or three shots against a try-out surface, and adjusting the spray as necessary. Also, work in a very well ventilated room, especially if you are using lacquer. If the fumes are troublesome, see that there is a good draft of air passing through the room and use an electric fan, if necessary, to keep the air in motion. The ventilation must be good."

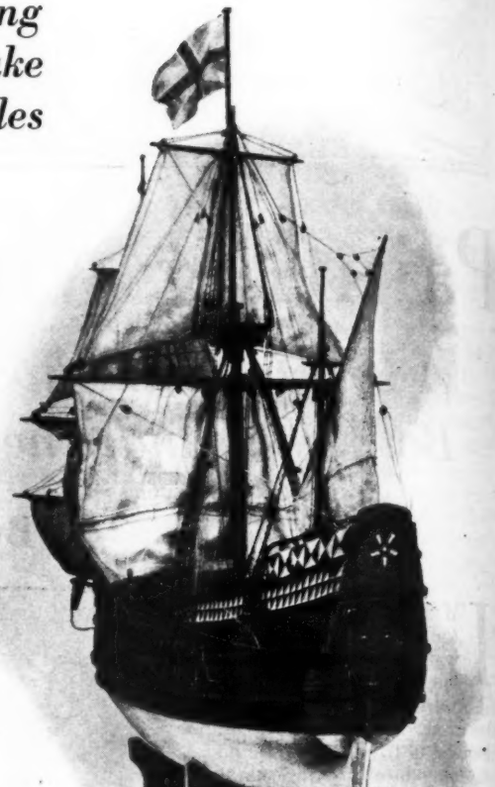
While Mrs. Andrews was experimenting for herself, I pointed out that in spraying new wood with lacquer, the same preparatory treatment should be given the surface as for brush coating. More care, if anything, should be used, for the spray will not fill irregularities to the same extent as a brush coat.

EXCEEDINGLY soft woods should be given a coat of *pure*, thin white shellac to seal the porous surface and then smoothed with very fine sandpaper and dusted off. In fact, it is almost always advisable to apply a priming coat of shellac so that if the grain has a tendency to rise with the application of painting materials, the fuzz so caused all over the surface may be sandpapered off, producing a perfectly level surface for the lacquer coats. Lacquer itself does not stand sandpapering well. Commercial shellac known as a 4- or 5-lb. cut—that is, 4 or 5 lbs. of shellac to a (*Continued on page 111*)

Our *Mayflower* Takes Shape

Step-by-Step Instructions for Completing the Hull—How to Color the Model and Make Deck Fittings—The Second of Four Articles

By E. Armitage McCann



Few models are as picturesque as this one of the *Mayflower*. Note particularly the ornamentation

NOW that we have the hull of our *Mayflower* model well under way, a few further notes will be of interest in regard to the history of her voyages.

As every school child knows, a band of Separatists from the Church of England (Anglican Church) fled to Holland in 1608 and twelve years later 120 of them decided to sail to America. They chartered two small trading vessels, the *Mayflower* and the *Speedwell*, and sailed from Delftshaven in July, 1620, calling first at Southampton and then at Plymouth, England. Here it was found that the *Speedwell* was unseaworthy, but eventually 102 Pilgrims sailed in the *Mayflower*. They landed on the Massachusetts coast in December and founded the township of Plymouth.

Only some twenty-seven original families appear to have been founded by the passengers of the first voyage, but the *Mayflower* made several voyages to this country: alone with 102 passengers in 1620, then in company with five other vessels in 1629–30, and again to Charleston in the latter part of 1630 with three other ships. The records also give the voyage of a *Mayflower*, presumably the same, with another vessel from Southampton to Boston and Salem in 1629.

She appears to have been owned by Thomas Horth or Howarth of Great Yarmouth, with William Bullard and later William Pierce as master. Thomas Webber of Boston is said to have owned her at one time.

Her end is shrouded in mystery. The people of Beaconsfield, in Buckinghamshire, England, claim that her timbers are in a barn in that vicinity, but this has not been proved.

Little as is known about her, the *Mayflower* is one of the most famous of ships. She will be forever enshrined in the hearts of Americans as a glorious symbol of the spirit of freedom that animated the Pilgrim Fathers.

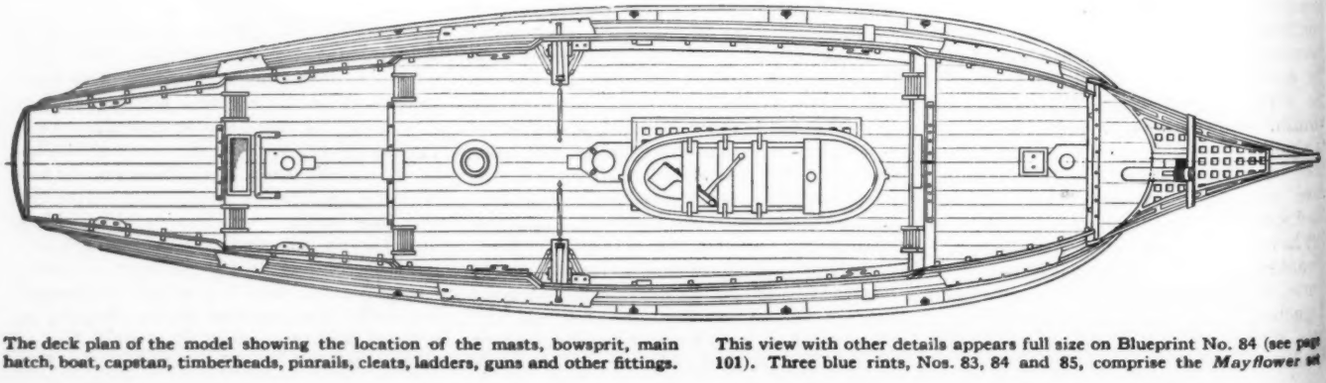
Any readers who missed the first article on the construction of this model in the April issue can easily catch up with the work. All that is necessary is to send for Popular Science Monthly Blueprints Nos. 83, 84 and 85, which contain full size drawings of the hull, rigging and all essential details. These blueprints are uniform with previous plans issued in connection with ship model articles and can be obtained for twenty-five cents each. (See the list on page 101.)

It is best to fit the rudder next, but it need not be put in position until later. Its shape will be seen in the sheer plan (Blueprint No. 83) and the illustration on page 92. It may be fastened on with double-pointed nails, but a better job is to make five eyebolts from pins and drive them into the sternpost; then drive other pins into the rudder, bending them over at a right angle to form hooks to lie in the eyes; and in that way hang the rudder so that it will swing from side to side. Paper strips can then be glued to the stern and to the rudder to represent pintle and gudgeon straps. Those who know how to make more elaborate pintles and gudgeons can, of course, do so.

I want it to be understood clearly that those who know of better ways of doing things than here described are entirely at liberty to make use of their own knowledge; and those who wish to simplify may do so also. All I ask readers to do is to follow the measurements and general appearance of my model unless they have positive reasons for departing from them.

The tiller may be a piece of hardwood made either to fit over the rudderhead or to be mortised through it. It goes through an oblong hole in the stern at the right height. It should extend to the half deck and be worked with a whipstaff, but as this will not show, it need not be fitted.

The headrails and trail boards are next fixed. They may be fret-sawed from pieces of hardwood or three-ply stock not more than ⅛ in. thick. Their shape, full size, may be seen on Blueprint No. 84; they are also shown at the top of page 113 and in plan view in the lower illustration on this page. First try them out in cardboard to be sure that when the end is in position on the (Continued on page 92)



The deck plan of the model showing the location of the masts, bowsprit, main hatch, boat, capstan, timberheads, pinrails, cleats, ladders, guns and other fittings. This view with other details appears full size on Blueprint No. 84 (see page 101). Three blue rints, Nos. 83, 84 and 85, comprise the *Mayflower* set

For All a Boy's Treasures

Two Cabinets That Hold Books, Sporting Equipment and Sundry Collections—Built by the Easiest Methods

By THOMAS E. JEFFRIES

HERE is a cabinet planned for a Boy Scout. A smaller one, illustrated on pages 96 and 97, was made for a boy interested in geology and chemistry. Both will continue to be useful after the boys grow up to be men, if they continue to like an outdoor life.

The designs are simple and are intended, as is the following description, for amateurs.

Get such lumber as your local mill supplies. I use long leaf yellow pine, dressed ⅞ by 11½ in., and also keep a supply of California fruit boxes for thin stuff. The bottoms of prune boxes are just the thing for the bottoms of small drawers. If possible, have the main pieces dressed and cut to dimensions at the mill, according to the bill of lumber on page 97.

As the construction of both boxes is similar, only the larger one will be described.

First, I should get out the face pieces for the small drawers and the partitions for their rack. In assembling the rack, which is shown on page 96, use two drawer face pieces, one at each end, to space the partitions.

THE main shelves are 11⅛ in. wide, or ⅜ in. less than the sidepieces, to allow for the ⅜-in. back. I got mine 11½ in. and sawed off a ⅜-in. strip, for which I found use later.

Next get out your two main sidepieces. The hole at the bottom may be as small as 1 in. Bore until the point of the bit just comes through, then turn over and bore from the other side. Mark where the top shelf goes, square across and temporarily nail a thin strip along your pencil line so you can easily hold the shelf in position. Nail through the sides with sixpenny finishing nails. In the same way fasten the shelf at the top of the bottom drawer.

Place temporarily two of your 2-ft. shelves, one at each end, to serve as guides while nailing the 3 ft. 8 in. partition. Cut a strip 9 in. long and use it at all four corners to space the upper 2-ft. shelf. Use this the same way to space the next lower shelf. Then lay the cabinet face down, square it, and nail a strip diagonally across the back to hold it square.

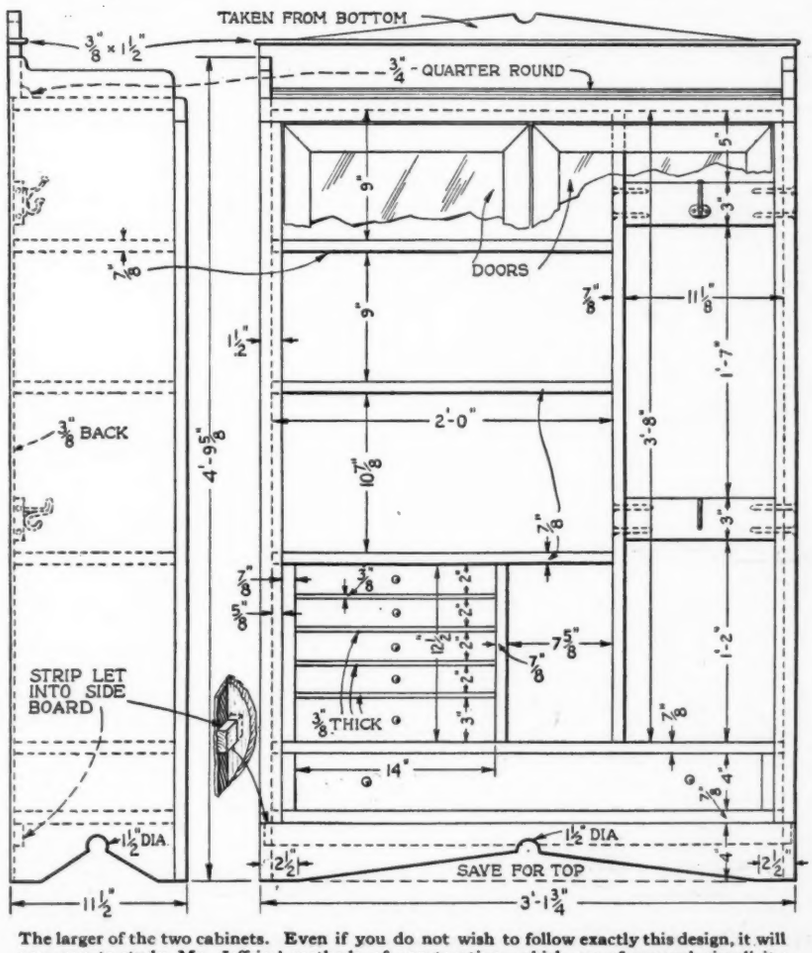
Get out two ⅝ by ⅞ by 12½ in. pieces and nail along the left-hand side of the drawer rack. Slide the rack into position, brace it from the 3 ft. 8 in. partition, and place the lowest 2-ft. shelf on top of it. After nailing this shelf at each end, nail the rack at top and bottom.

Lay the cabinet on its back and place the bottom shelf, using your 4-in. bottom drawer face piece standing on end for a guide in spacing it.

Put on the 1½ in. wide piece with rounded edge across the top. Have it a little long, so that you can dress back to solid wood, and drill for nails at the ends to prevent splitting. Put the 1½-in. pieces on the front edges of the sides and place the bottom crosspiece. Be careful in cutting it so that you can use the piece cut out as an ornament at the top. Note that the bottom piece laps the bottom shelf a little.

STAND the cabinet on end and place the top 4-in. crosspiece. Turn face down and place the 1½-in. piece at the bottom, letting it into the sides as shown. Then put on the ⅜-in. strip at the top and add the ornamental piece cut from the bottom. Nail on the ⅜-in. back, place the ½-in. quarter round molding at back of

(*Continued on page 96*)

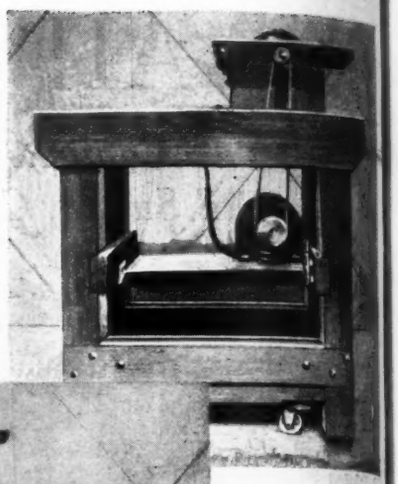


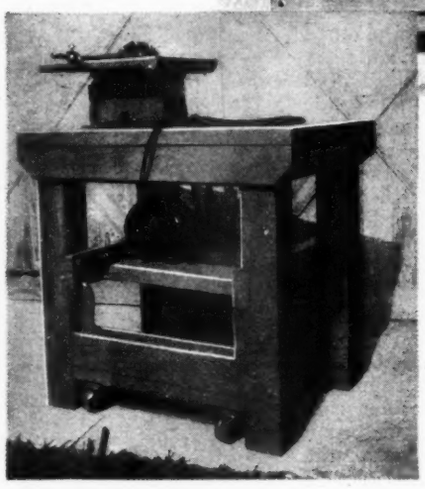
The larger of the two cabinets. Even if you do not wish to follow exactly this design, it will pay you to study Mr. Jeffries' methods of construction, which are of unusual simplicity

A Movable Saw Table

Can Be Wheeled on Casters to Location and Is Suitable for Sawing Long Stock

By JOHN G. HANNA





Above: The wooden cam levers have been pushed down so that the table is supported on casters ready for moving to the most convenient location for the job in hand. This is of especial advantage in a small shop where every foot of floor space is in use

At left: Cams are up. The table is resting on its legs, ready for work as soon as the plug is inserted in an outlet

MANY home workshop fans probably find themselves in my fix. A bench saw has to be set up in the middle of the shop to get room for handling long boards, yet the entire floor space of the little shop is needed for assembling such jobs as a screen door, a kiddie coop or a garden seat. After cogitating over these conflicting requirements for some time, I developed the movable table illustrated, which is presented here for the benefit of fellow sufferers from small-shop cramps.

It is nothing more nor less than an adaptation, in simple but highly efficient form, of the cam arrangement commonly employed to lift movable typewriter stands and the like. Pushing down the four cam levers lifts the table onto ball bearing casters, and it can be easily rolled where you wish. When the levers are lifted, the table drops down solidly on its legs—so solidly that it would carry a 4-H.P. outfit, instead of the ¼-H.P. saw it now has. Looking to the future, I plan to mount more machines and a heavier motor.

Obviously, the table would serve as well for mounting a lathe, or any other bench machine, or a combination of machines.

The bill of material lists so-called four by fours for the legs. Actually these are 3½ by 3½ in. nowadays. Legs 3 in. square would be heavy enough, but if you want them, the only way to get them is to buy four by fours and then pay as much more to have them sawed and planed down to 3 in. So with all the material listed; the bill names the common designations, and the drawing shows the actual thickness you will probably get.

The total cost of all the lumber in this bench, which is built of good hard yellow pine, was $1.68; the entire cost amounted to $6.41, including rather expensive brushing lacquer finish.

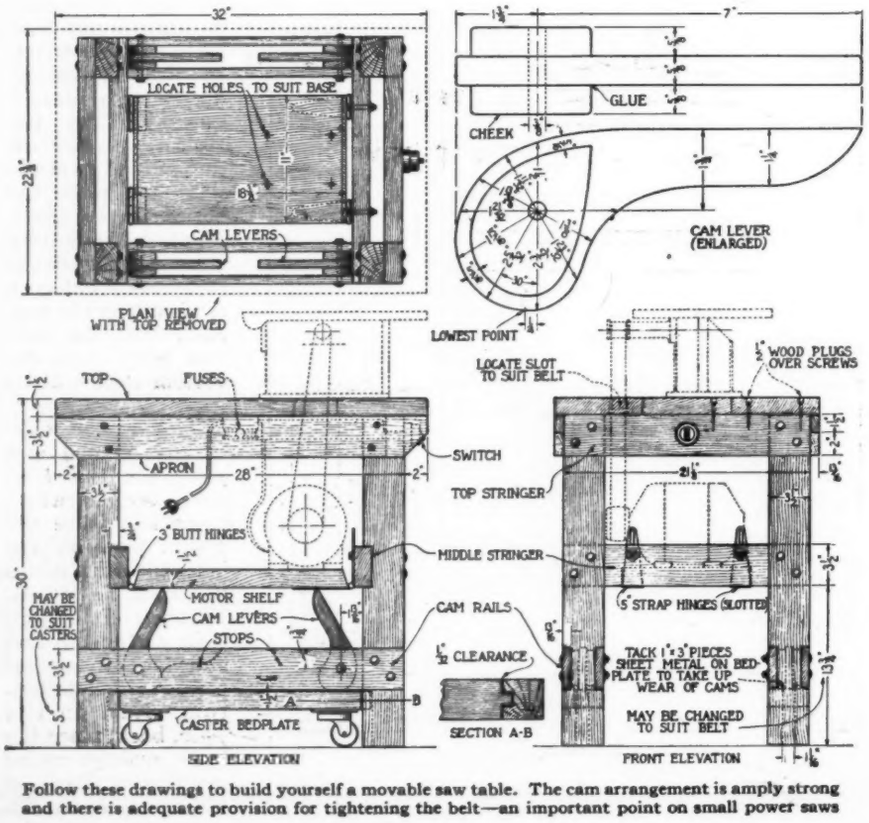
Pine, either yellow or white, and Douglas fir are satisfactory woods for such a job. Hardwood for the top, maple, birch or oak, is splendid if you wish to go to the extra expense. For a less expensive finish than lacquer, use a good floor paint or varnish.

The top dimensions, 24 by 32 in., were selected because they fit in an out-of-the-way corner of my shop, between door and window. They give extra room to mount a small bench band saw on one back corner of the table, and a bench jointer on the other corner, which I hope to do some day, driving them from a countershaft fixed to underside of table. My three alleged 8-in. boards for the top came to a width of 22¾ in. Maybe yours will do better—or worse! Find out first.

ANOTHER point to watch for trouble is the height of the casters. It would be a good idea to get yours and screw them to the caster bedplates (pieces of two by four with a tenon 1 in. wide and ¾ in. deep formed on each end). Then measure the actual height and notch the legs to bring the cam rails ⅛ in. higher than this. I cut my notches according to catalog dimensions of casters, and later found them ¼ in. higher, so had to sink them into the bedplates that much.

Another variable detail is the height of the middle stringers that support the motor shelf. Bench saw outfits usually include an endless belt, and if you want to use the one that comes with your outfit, check up on the center-to-center distance. If you use a laced belt, of course it can be made to suit the shelf location shown.

Belt slip is a most exasperating trouble with small bench machines. I devised and discarded a dozen methods for belt adjustment before I hit on the one shown. The middle screw hole in one leaf of a strap hinge is elongated with a small round file (*Continued on page 118*)



Follow these drawings to build yourself a movable saw table. The cam arrangement is amply strong and there is adequate provision for tightening the belt—an important point on small power saws

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Wood Turning for Beginners

Centering and Clamping Stock -Turning Cylinders—Shoulder and Taper Cuts

By Herman Hjorth

WOOD turning is rapidly becoming one of the most popular of home workshop pursuits. The work is fascinating in itself and the products are useful and beautiful.

The hobby of wood turning has been enjoyed by a few enthusiasts ever since the days when royalty in Europe amused itself with it in the seventeenth century, but heretofore the amateur mechanic has been handicapped because of the difficulty of obtaining small and inexpensive motor-driven lathes. Now a number of excellent home workshop lathes are available. Indeed, a lathe or a motorized combination machine will be soon taken for granted in the well-equipped home workshop, just as hammer, saw and plane now are.

When a lathe is purchased, the manufacturer usually gives directions for setting it up and provides a set of the more essential tools,

Fig. 1. Use a wooden mallet to drive the live center into the wood. This is particularly important when using hard wood

Fig. 2. Start cut near dead center and move tool toward it. Hold tool and stand as shown in the illustration above

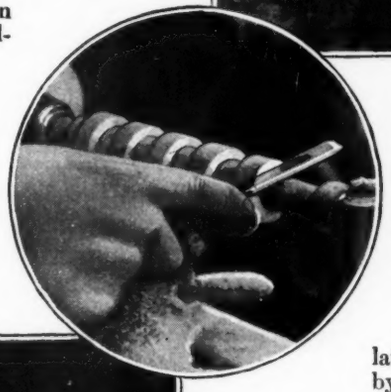

Fig. 3. Test the end for squareness by resting the side of the tool against the wood. If no light can be seen between the tool and the work, the edge must be perfectly square

Fig. 4. Use a parting tool and calipers. Groove the work to the required diameter at points about 1 in. apart. The grooves serve as depth guides and make it easy to turn a true cylinder

but the actual operation has to be learned by experience. The first step is to center and clamp the stock.

Saw the stock to dimensions. If it is square or rectangular, draw diagonals on each end. The center of the piece lies in their point of intersection. If the stock is irregularly shaped, set a pair of dividers to approximately half the thickness of the piece, hold one of the legs of the dividers against one of the edges, and scratch a line parallel to it. Repeat on the other three edges. The center then may be determined. A marking gage may be used instead of the dividers (see Fig. 7). If the wood is very hard, make a saw cut on the two diagonals on one end, and bore a small hole in the center of the other end.

Remove the live center from the headstock of the lathe. Usually this is done by pushing it out with an iron rod, which can be inserted from the opposite end of the headstock. Drive the center with a *mallet* into that end of the wood on which the diagonals were sawed, so that the prongs enter a saw cut. Do not drive the wood on the live center while it is in the lathe if it can be avoided, as the blows are injurious to the bearings (see Fig. 1).

Turn the other end of the wood up and drip machine oil on it. Allow the oil to soak in. If the wood is not oiled or if the oil has dried, the friction on the dead center will cause the wood to burn.

Replace the live center in the headstock and press the wood against it, so that its spurs enter the depressions previously formed in the wood. Clamp the tailstock firmly so that the point of the dead center is a couple of inches away from the end of the wood; then turn the handwheel until the dead center enters the end wood so deeply that the wood cannot be revolved by hand. Loosen the handwheel a little until the wood can be revolved

Fig. 5. Smooth the cylinder with square-nose turning chisel or a firmer chisel with a long blade

Fig. 6. Using a skew chisel to square both ends. Be careful not to cut too close to the live center, to avoid damaging tool

quite freely by hand. Clamp the dead center in this position.

Adjust and clamp the tool rest so that it is about ⅛ in. away from the edge of the wood that is nearest to it when the stock is revolved. Fasten the T-rest at the correct height, which varies somewhat with the height of the person; it is never below the center of the piece, however. It is generally from ⅛ to ¼ in. above the center. Turn the pulley by hand and make sure that the wood has sufficient clearance. See that the clamps are all tight before turning on the power.

If the stock is well centered and not over 2 in. square, the lathe may be started with the belt running on the smallest step of the cone pulley—that is, at full speed. Suppose you wish to turn a cylinder (Fig. 8). Use the gouge for the first cut. Grasp the handle near the end with the right hand and hold the blade firmly against the T-rest with the left hand, so that the palm of the hand near the wrist and also the little finger are in contact with the T-rest. Hold the handle of the gouge well down and roll the gouge a little towards the right. This will throw the shavings away from you. Raising the hand holding the handle will start the gouge cutting (Fig. 2).

START cutting a couple of inches from the dead center and move the gouge away from you towards the dead center. Start the next cut a couple of inches farther to the left and continue making similar cuts until only an inch or so is left. Roll the gouge towards you and move it towards the live center to round off the last part of the stock. When too long a cut is taken while rounding off the corners, large chips are liable to fly off and injure the operator.

Move the gouge freely from one end of the piece to another until it is perfectly cylindrical and a little larger in size than actually needed. Stop the lathe and move the T-rest closer to the stock.

Set the outside calipers to about 1/16 in. more than the finished diameter. Grasp the parting tool in the right hand and the calipers *(Continued on page 94)*

Airplane Model for Racing

How to Build a "Pusher" with Two Propellers for Long Distance Flights—Has an A-Shaped Fuselage and a 35-in. Wing-Spread

By J. D. BUNCH and AVISON F. KOCH

In contests for duration a "pusher" model with twin propellers almost invariably wins

FOR long distance and duration flying, the most successful airplane model design is a "pusher" plane with twin propellers. The propellers are in the rear and push the model forward.

This type of plane can be made lighter and stronger in proportion to its power than any other design, and all the records for distance and duration are held by it. Of course, the delicate, superlight contest model would be much too exacting in construction for the beginner.

The design illustrated is a simple but capable flyer, and one easy to construct. It will make flights of over 1,500 feet at high altitudes.

You will be greatly helped, if you undertake the construction of this remarkably efficient little model, by the new POPULAR SCIENCE MONTHLY Blueprint No. 86, which you will find listed on page 101. This blueprint contains complete working drawings and various full size details of the model, which could not be given in the restricted space of a magazine page.

The fuselage is a frame constructed in the shape of the letter A. The longerons are white pine 1/8 by 1/4 by 30 in. The front ends are shaved off at an angle so they will fit snugly together. The assembly at the front is completed with a U-shaped hook to hold the motor rubber; this hook goes around the end of the fuselage and is bound with silk thread and glued.

There are two compression struts of 1/16 by 1/8 in. bamboo. The ends of these are sharpened and glued into slits made in the longerons by forcing the point of a knife blade into the side grain of the wood. The front strut is placed 6 in. from the front end and holds the longerons 1 1/8 in. apart. The other is located 18 in. from the front end and holds the longerons 3 11/16 in. apart.

Near the rear end the fuselage is cross braced with two pieces of bamboo 1/16 by 3/32 by 6 7/8 in. The ends of this X-brace are about 3 1/2 in. apart and are secured to the longerons in the same manner as the compression struts.

The rear ends of the longerons are tapered down for a distance of about 1/2 in. to meet the propeller bar. This taper is reinforced with silk thread binding.

The propeller bar is white pine 1/8 by 1/4 by 8 in. The propeller shaft bearings may be made of 1/16 in. inside diameter brass tubing 1/2 in. long. One end must be flared so it will not slip through the bearing support straps. Suitable bearings also may be purchased from airplane model supply houses. The bearing straps are made of about 30-gage aluminum, or, if this is not available, tin cut from a light can will do very well. The straps, which are 3 in. long and 3/16 in. wide, are looped around the bearings and carried above and below the propeller bar and then are bound with silk thread and glued. At a point 3 1/8 in. on each side of the center of the propeller bar a 5/8-in. brad is driven through each bar and into the ends of the longerons. Put a drop of glue on the ends before forcing the longerons in place.

Glue two blocks of white pine 1/8 by 3/8 by 1/2 in. to the top of the longerons 4 in. from the front. The front spar of the forward wing, or elevator, rests on these blocks, which raise the spar 3/8 in. and give the elevator the necessary angle of incidence.

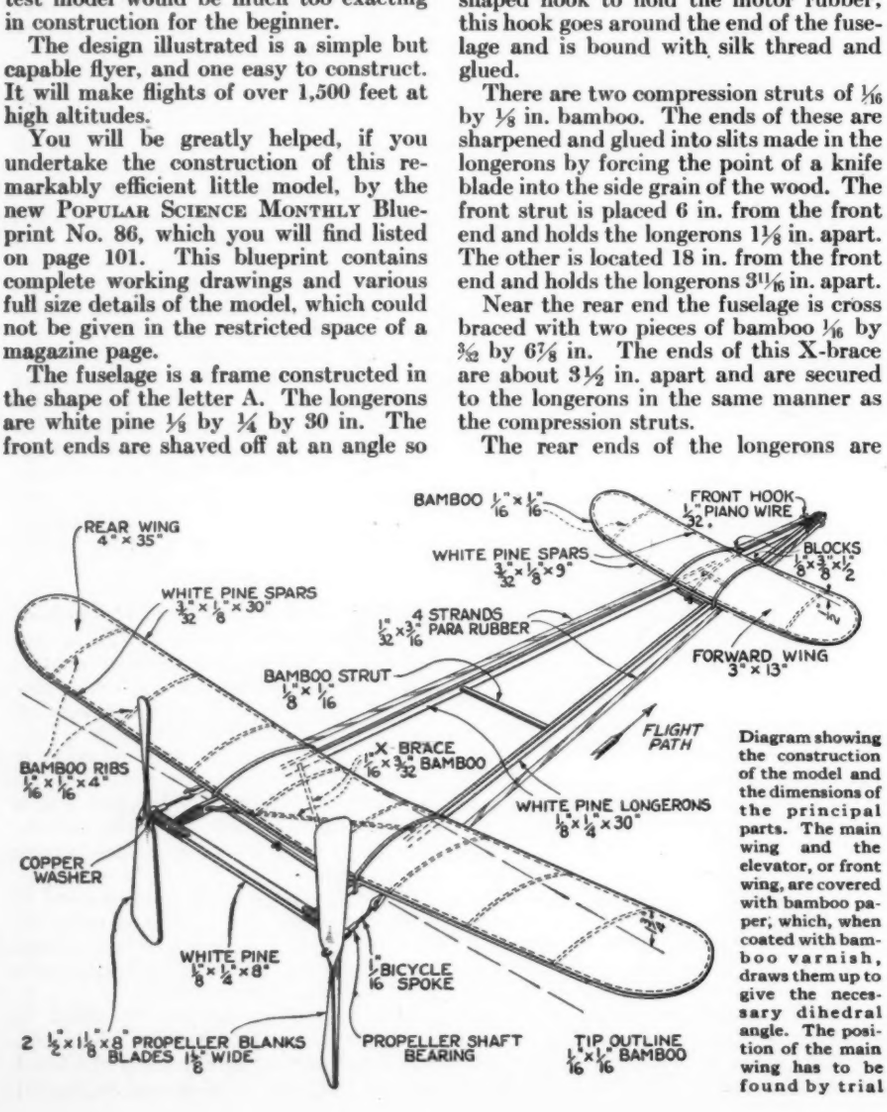
REAR WING 4" × 35"
WHITE PINE SPARS 3/32" × 1/8" × 30"
BAMBOO 1/16" × 1/16"
FRONT HOOK 1/32" PIANO WIRE
WHITE PINE SPARS 3/32" × 1/8" × 9"
BLOCKS 1/8" × 3/8" × 1/2"
4 STRANDS 1/32" × 3/16" PARA RUBBER
FORWARD WING 3" × 13"
BAMBOO STRUT 1/8" × 1/16"
FLIGHT PATH
X BRACE 1/16" × 3/32" BAMBOO
BAMBOO RIBS 1/16" × 1/16" × 4"
WHITE PINE LONGERONS 1/8" × 1/4" × 30"
COPPER WASHER
WHITE PINE 1/8" × 1/4" × 8"
1/16" BICYCLE SPOKE
2 1/2" × 1 1/8" × 8" PROPELLER BLANKS BLADES 1 1/8" WIDE
PROPELLER SHAFT BEARING
TIP OUTLINE 1/16" × 1/16" BAMBOO

Diagram showing the construction of the model and the dimensions of the principal parts. The main wing and the elevator, or front wing, are covered with bamboo paper, which, when coated with bamboo varnish, draws them up to give the necessary dihedral angle. The position of the main wing has to be found by trial

THERE are two propellers, one right-hand and one left-hand; that is, they must be carved so they will rotate in opposite directions. The propellers are of the wide blade, club type. They are made from a block of white pine 1/2 by 1 1/8 by 8 in. Draw the blade outline on a piece of paper to make a pattern, or use the full size drawing on Blueprint No. 86. With this mark the outline on the blocks. Cut to the outline, thus making the blanks.

Before carving the blanks, drill them accurately for the propeller shaft, which is bicycle spoke wire 1/16 in. in diameter. The propellers are carved with a sharp knife. The rear sides are concave and the front sides convex. The contour of the blades in cross section should resemble a wing curve. *(Continued on page 117)*

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4. What are the four forms of English composition?
5. What is psychology?
6. Who were Donatello, Cellini, Bologna, Rodin?
7. What is the Milky Way?
8. Who was Delilah?
9. What famous speech begins: "Friends, Romans, countrymen, lend me your ears"?
10. What do the following mean: (a) "Sprechen Sie deutsch"; (b) "Parley-vous francais"; (c) "Hablan Usted espanol"?
11. How far does a falling body drop in the first second after starting from rest?
12. What does "ibid." mean?
13. Who was the Roman god of war?
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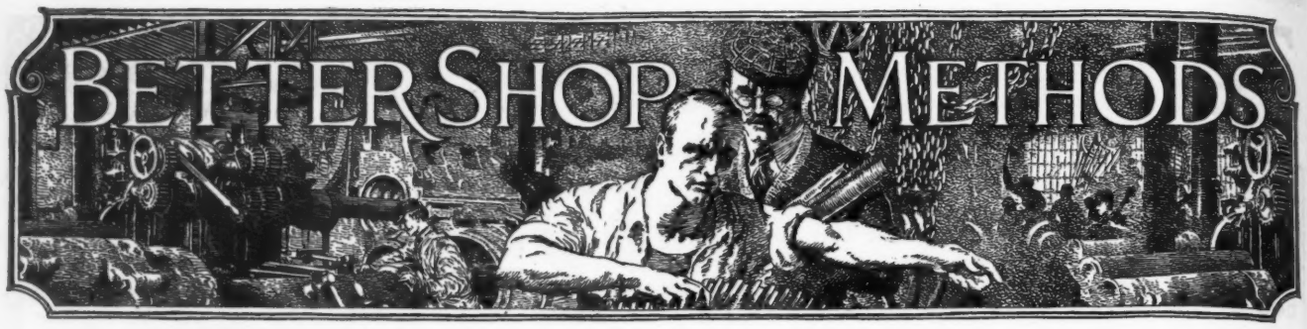
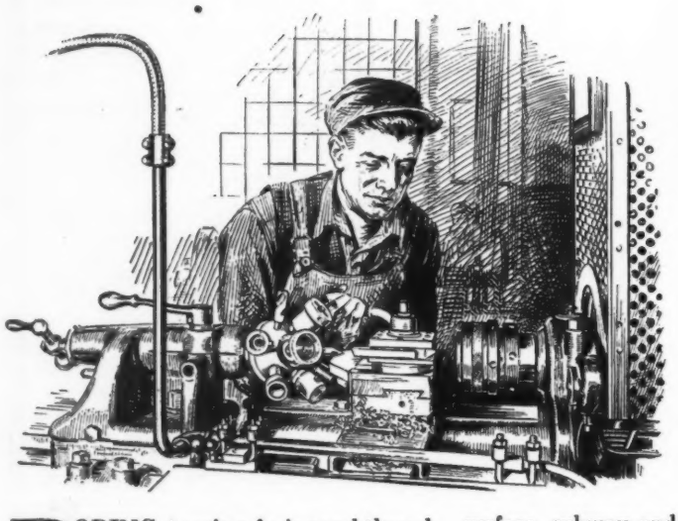


Making the Most of a Lathe



How a Turret, Four-Way Tool Post, Spring Chuck and Other Shop-Made Attachments Save Time in General Repair Work

By Albert M. Thomas

In a large street railway repair shop is a 14-in. lathe that can compete favorably with special machine tools. Among the attachments are a spring collet chuck, a four-way tool post and a six-tool turret center

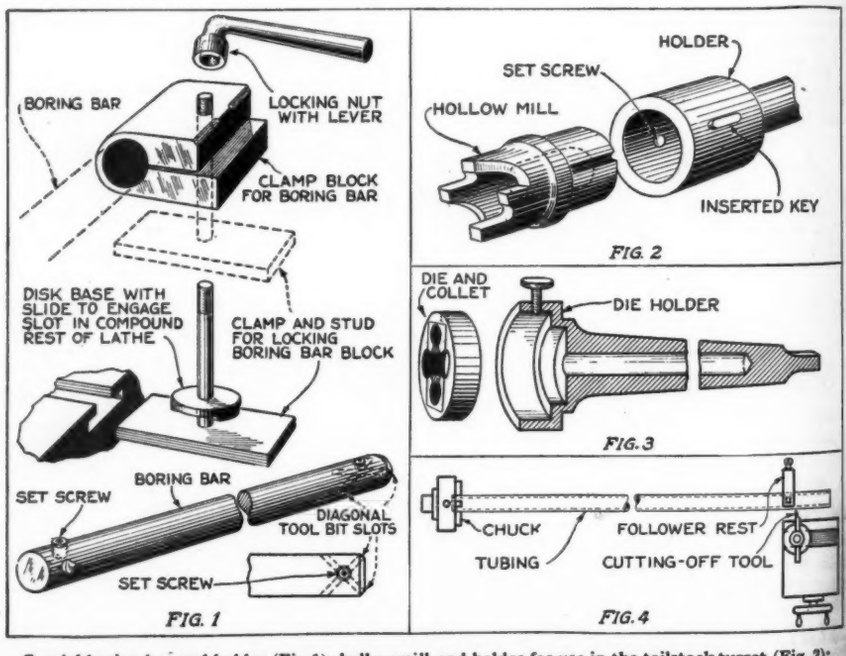
BORING, turning, facing and thread cutting by the method we call chasing are ordinarily the principal uses to which an engine lathe is put. By many lathe hands, machinists and even foremen and executives, these time-honored functions of the "king of machine tools" are still considered its only duties. Nevertheless, in the small jobbing shops and in the general repair shops of railroads and large manufacturing establishments, the range of usefulness of the engine lathe is being extended more and more, especially as it does not make for efficiency in these shops to install many special machine tools, which could not be kept in use more than a small percentage of the working day.

There are always jobs coming into a general repair shop that seem to call for the particular functions of some highly specialized tool. At such crises the constructive imagination of the executive, foreman and workman must devise a substitute for the special machine. And then it is that the engine lathe usually saves the day. Indeed, much of the work of other standard machine tools—milling machine, shaper, planer, drilling machine, grinder, slotting machine and bolt cutter—can be done on the engine lathe simply by attaching the necessary fixtures, so long as the lathe available is a fairly modern machine and the size of the work to be performed comes within its range.

As an example of what can be accomplished in this way, I shall describe a 14-in. lathe in the repair shop of a New York City railway company which operates surface, subway and elevated lines. Besides the usual complement of attachments, the lathe has the following time saving devices, all shop made: A special boring bar (Fig. 1), hollow mills and holders (Fig. 2), die holders for tailstock center (Fig. 3), a six-tool turret center and four-way tool post, as shown in the upper illustration on this page, and a spring collet chuck (Fig. 5, page 105). By the use of these fixtures, this machine can compete favorably with many special machine tools in respect to speed, accuracy and ease of operation.

The boring bar (Fig. 1) is clamped in a slotted block, which has a large hole for the bar and another hole at right angles for the clamping bolt. The block rests on a circular plate, the underside of which is cut to fit the slot on the compound rest. The clamping piece, to which the stud is permanently *(Continued on page 105)*

MANY time-saving shop ideas are contained in the continuation of the Better Shop Methods Department, on pages 86 and 104 to 107.



Special boring bar and holder (Fig. 1); hollow mill and holder for use in the tailstock turret (Fig. 2); die holder for tailstock (Fig. 3); diagram showing how steel tubing is cut into bushings (Fig. 4)

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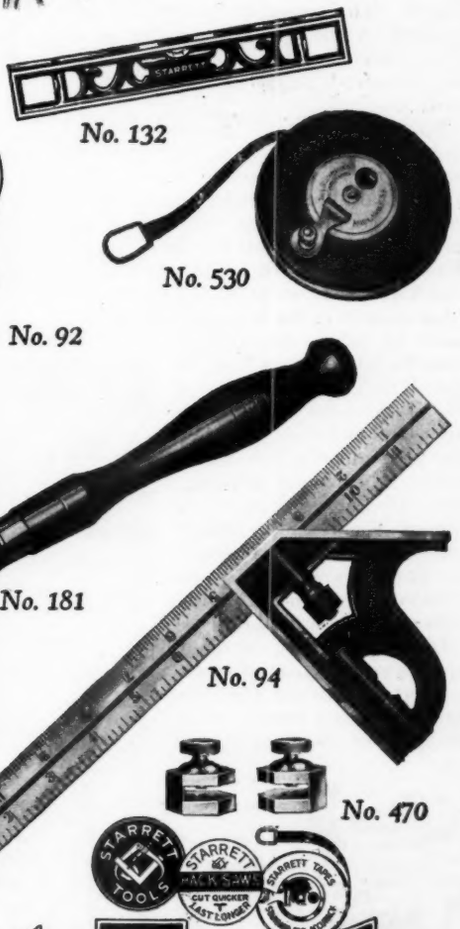

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Kinks to Aid Machinists

Taper Boring and Milling Attachments for a Lathe—Hack Saw Pad—Jig for Oil Holes—Other Short Cuts

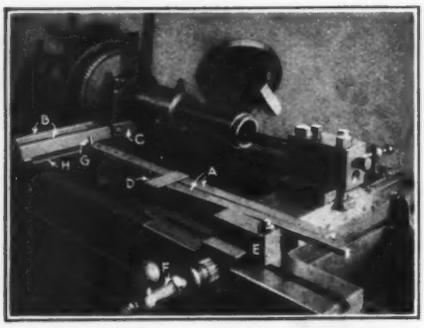

Fig. 1. A cheaply and quickly made attachment for boring taper holes on the lathe

AN ENGINE lathe may readily be arranged for boring taper holes up to its capacity with very simple equipment, as in Fig. 1. The cross-feed screw *F* is disengaged to allow free movement of the cross slide. A clamp block *E* is fitted to the cross-feed ways, and is set at any point required.

Two long straight parallel bars *A*, about ½ by 1 in., are made to give the taper. One of the bars is several inches longer than the other—long enough to reach to the headstock, where it is connected with a support *B*, which consists of two bars clamped to the web of the headstock as shown at *C*. The longer bar *A* has a series of pin holes drilled 2 or 3 in. apart to allow the attachment to be adjusted lengthwise. Two pins, one on either side of the bars *B*, hold the taper bars endwise. Another bar *H* supports the taper bars in a horizontal position, while the cross slide ways support them at the other end. A dowel pin at *G* keeps the two bars in lengthwise relation, and a clamp *D* holds them in at the desired taper.

To obtain any desired taper, a piece of round stock is inserted between the two bars *A* in such a position that the taper of the bars equals half the taper for the hole to be bored. This may be determined by calipering the bars. When they are properly set, clamp *D* holds them in position. The inserted cylindrical piece is also retained within the clamp.

A stiff coil spring is placed at the back of the cross slide to shove it against the taper bars when backing the carriage away.—O. S. MARSHALL.

WHEN much sawing must be done with a hack saw, the friction is likely to chew the "hide" away in the thumb crotch of the left hand. Take an old piece of square water-pump packing, slit the ends, and push it up in the end of the saw frame as shown in Fig. 2. Round off the inside corners of the packing where the hand touches it. Then see what "a whale of a difference" it makes!—F. B.

PACKING rings frequently have to be ground or filed to size. By the ordinary method it is a rather tedious and uncertain operation, but with the "sizer" illustrated in Fig. 3 it is done easily and certainly. The device is merely a piece of brass a little larger than the ring. A groove is turned on one end large enough so that the ring has to be sprung on it; in width it is a little shallower than the thickness of the ring. A ring to be fitted is snapped on the holder and given a few rubs across a sheet of emery cloth on a smooth bench. The weight of the holder is an advantage in rubbing down the ring.—WILLIAM J. DOUGLASS.

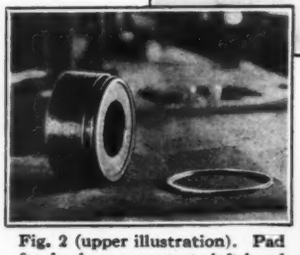

Fig. 2 (upper illustration). Pad for hack saw protects left hand

Fig. 3 (above). A handy holder is aid in "sizing" packing rings

Fig. 4 (at right). Seat for use on derrick or similar machine

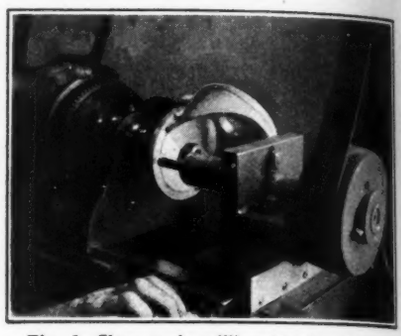

Fig. 6. Shop made milling attachment on cross slide. The work is rotated by hand

IT IS a strenuous job to stand in one place all day and manipulate machinery that requires both hands and feet to operate the levers, yet in many instances it is impossible to install an ordinary seat because of lack of room. One solution is an old motorcycle seat, mounted as in Fig. 4 on a steel rod with a number of holes in it, which allow it to be adjusted to any height in the section of the pipe used as a base. The pipe is welded to the floor, and a small bolt, placed through it and the rod, holds the seat in any desired position.—JOSEPH C. COYLE.

THE average jobbing shop does not possess a complete assortment of lathe dogs and it frequently happens that a dog cannot be found to suit some especially heavy job. A pair of heavy V-type straps like those shown in Fig. 5 will accommodate varying diameters and take the place of the more expensive drop forged lathe dogs. The dimensions of the straps are governed to some extent by the size of the work. A stud driver is used with the straps; it is made to fit the slots in the faceplate.—H. L. W.

(*Continued on page 104*)

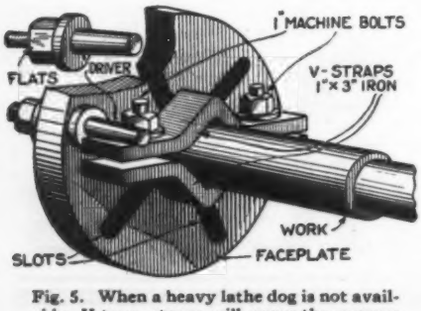

Fig. 5. When a heavy lathe dog is not available, V-type straps will serve the purpose

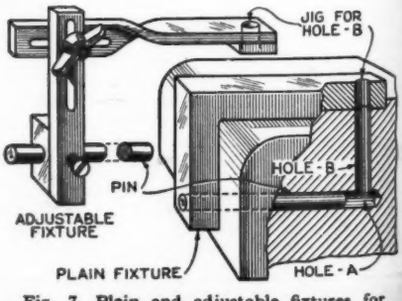

Fig. 7. Plain and adjustable fixtures for drilling oil holes that meet at right angles

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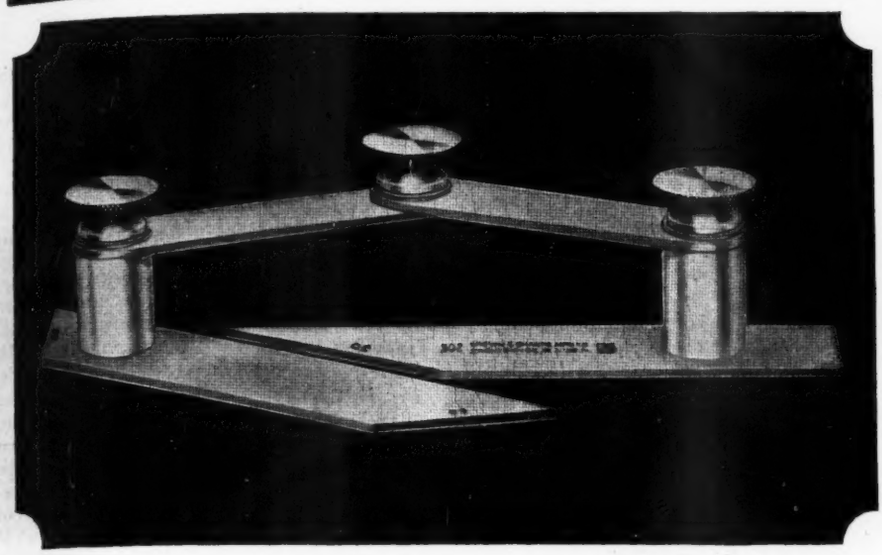

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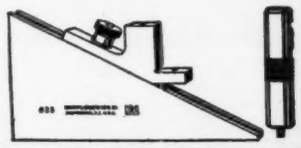

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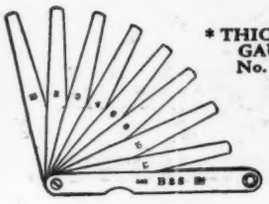

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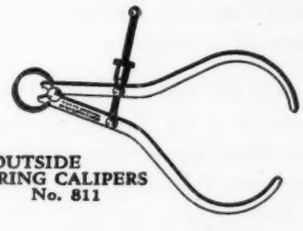

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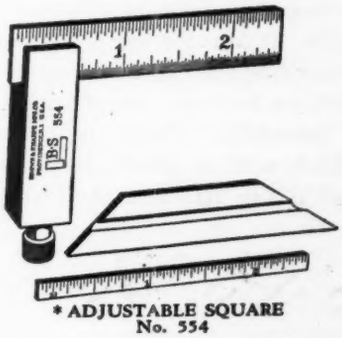

* ADJUSTABLE SQUARE No. 554

* *A description of this tool appears in Catalog No. 30*

WORLD'S STANDARD OF ACCURACY

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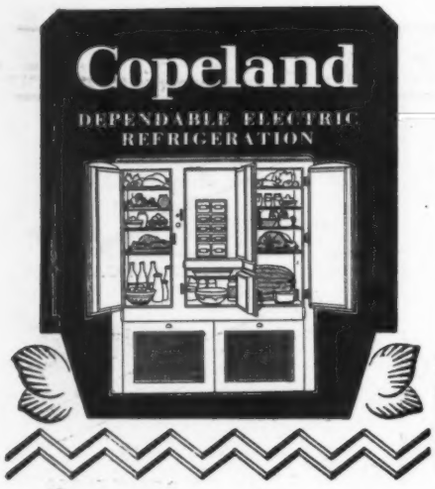


Colorful Copelands that harmonize with your kitchen

New De Luxe models . . . favorites of fashion . . . easily the finest of their kind. Gleaming white porcelain, offset in harmonizing colors of your own selection.

Masterpieces of efficiency, abounding in features such as cathedral-top doors, satin-finish hardware, electric illumination, double-depth dessert drawers, absence of drain pipe, cold-tray for crisping salads, 3 and 4 inches of solid corkboard insulation.

From 5 to 20 cubic feet of food storage space . . . 108 to 378 ice cubes at one freezing. These and other Copelands, some as low as $195 at factory, are described in a beautiful illustrated booklet which will be gladly sent to any one using the attached coupon.

COPELAND, 630 Lycaste Ave., Detroit, Mich.

*Name*_____

*Address*_____

P. S. M. 5-28

Double-Duty Screen Door

By Charles A. King

Both the screen frame and the storm sash are carefully fitted to the opening in the door

WHAT householder has not wished for a simple method of changing from storm doors to screen doors in the spring and back again in the fall? One solution is to make double-purpose doors of the simple type illustrated.

We will assume that the door opening requires a door 3 by 7 ft., which is a stock size. From kiln-dried white pine or other suitable lumber, prepare two stiles 1⅛ by 5⅛ by 85 in., one top rail 1⅛ by 5⅛ by 26 in., one bottom rail 1⅛ by 9⅛ by 26 in., and one middle rail 1⅛ by 3½ by 26 in. The allowance of 1 in. in length on the stiles and of ⅛ in. in the width of the top and bottom rails should extend beyond the actual size of the door to provide for its final fitting.

Lay out the position of the rails and make the joints, preferably with ½-in. dowels; if ⅜-in. dowels are used, there should be more of them. Glue and clamp up the door, being sure it is square. Then smooth and sandpaper it.

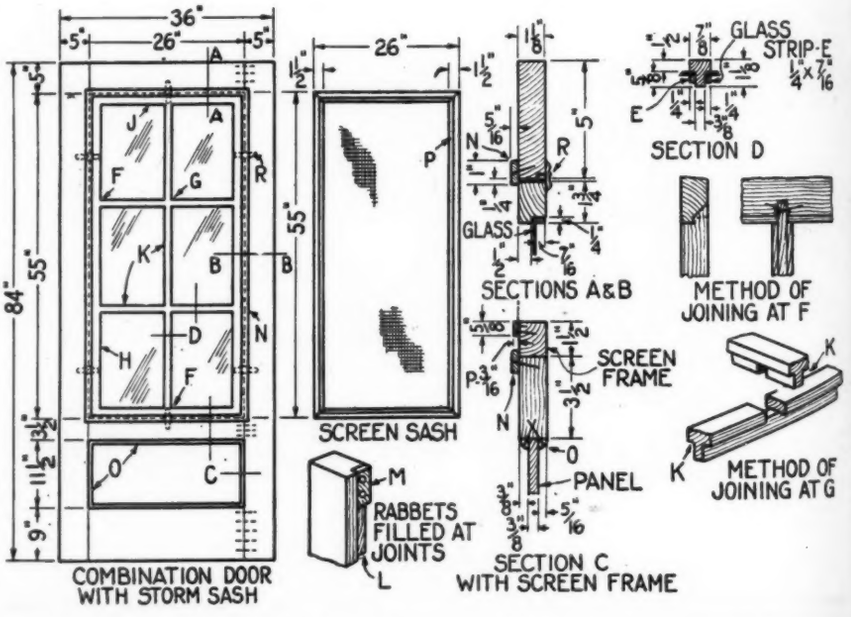
Prepare the quarter round molding *O* 5/16 by 5/16 in. by 9 ft., miter around one side of the edge of the panel opening, and fasten with ¾-in. No. 17 brads. Make a panel ⅜ by 11½ by 26 in., smooth and sandpaper it, and fasten it in place with quarter round molding on the other side of the panel. The stop strips *N* for the large opening are 5/16 by 1 in., of which 15 ft. will be needed.

For the screen frame are needed two stiles 1⅛ by 1½ by 55 in. and two rails 1⅛ by 1½ by 26 in. Assemble them with miter joints. Get out screen strips 5/16 by ⅝ in. by 15 ft. Stretch wire netting, preferably of copper, bronze or other nonrusting wire, and fasten with 4-oz. copper tacks. Fit the screen strips with miter joints and fasten with ¾-in. brads.

If extreme simplicity is desired, make two screen frames, cover one with wire netting as described and the other with a flexible glass substitute to be used in the winter as a storm sash. It is better, however, to make a storm sash with lights of glass, as shown. For this cut two stiles *H* 1⅛ by 1¾ by 56 in. (1 in. allowance in length), two rails *J* 1⅛ by 1¾ by 22½ in., and one muntin strip *K* 1⅛ by ⅞ in., by 9 ft. Rabbet these ¼ by ⅝ in. as shown in the two details marked *K* and *L*.

Mark the position of the top and bottom rails on the stiles; glue fillers in the rabbets, as at *M*, to receive the rails, and proceed to assemble the storm sash with dowel joints. Be sure the sash is square and true. Fit the muntins as in details *F* and *G*. Smooth and sandpaper the sash. Get out glass strips *E* ¼ by 7/16 in. by 22 ft. and fit them to the glass openings with butt joints. Cut the glass to fit and fasten the strips *E* with ⅝-in. No. 18 brads.

If a priming coat of paint is applied before the glass and screening are in place, considerable time will be saved, but in any case a priming coat and at least one wearing coat should be given. After painting, fix six brass or iron buttons *R*. The door is hung with the buttons on the inside.



The front of the door with storm sash in place; the screen frame; a cross section through the upper door rail and storm sash; a section showing middle rail, panel, and screen frame; other details.

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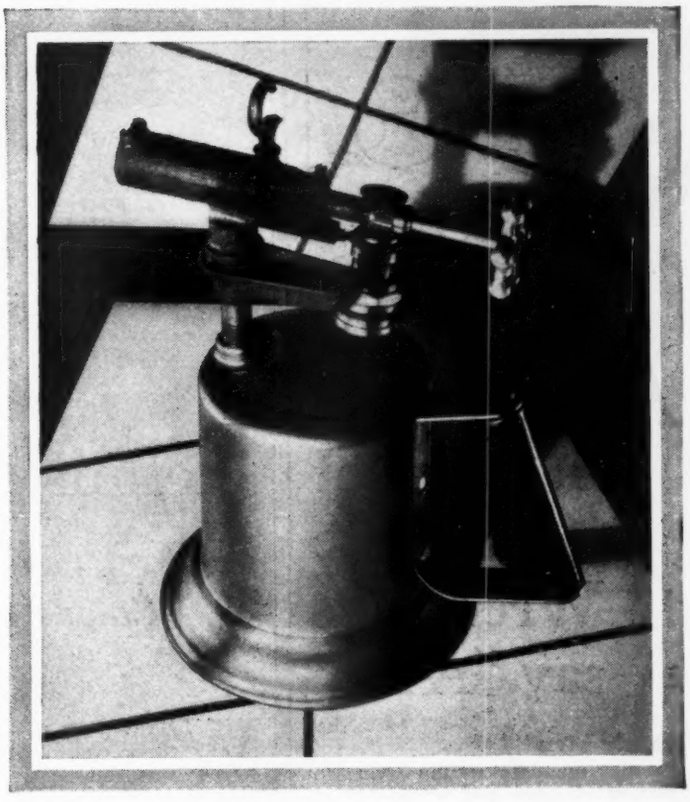
C & L Everedy 158

This blow-torch is especially made and priced for the man who likes to do odd jobs around the house, or to tinker with mechanical things. It will last a lifetime if it is not abused. The usual retail price is about five dollars. Most hardware, electrical and automobile accessory stores have it—or can get it for you quickly.
Look for the red handle.



We've put a *red handle* on it to be sure you get Clayton & Lambert

Ⓢ

NEXT time you're in a hardware store or electrical shop, if you happen to look over the line-up of blow-torches you'll see some with *red handles*. They're Clayton & Lambert torches. We put the red handle on so you could tell at a glance that you were getting the best value you can buy in a blow-torch.

The red handle doesn't make it work any better. The insides you can't see do that. But the red handle tells you the insides are right.

It's too bad you can't see what a lot of improvements we've made in blow-torches. Improvements that make them burn hotter, burn longer, and last longer too. But they're there, all right. And they give such definitely better service that users have made Clayton & Lambert the largest selling blow-torch in the world.

Here's an example. The little hole the gas comes out of must be fifteen-thousandths of an inch in diameter. If you spread that hole you might as well throw the torch away, for it won't work satisfactorily. Clayton & Lambert devised a way to make sure that hole couldn't be spread but at the same time whenever you close the hole you clean the carbon out of it so it can't clog. That's one of the Clayton & Lambert patents. There are flocks of others.

So when you need a blow-torch—and if you'd just think about it a minute you'll be surprised how often you do, for scraping paint, or fixing up the radio, or any number of jobs around the house—look for the blow-torch with the red handle, in the hardware or electrical store. Your money can't buy better.

C&L EVEREDY PATENT NOS. 1364194 & 1569479 OTHER PATS. PE... TRADE MARK

CLAYTON & LAMBERT MANUFACTURING CO.
DETROIT, MICHIGAN

C & L 32

This is one of the most popular blow-torches we have ever made. It is more expensive than the 158 *because it is made for much harder use. It is designed for the man who uses a blow-torch in his daily business and demands not only excellent performance but rugged ability to stand rough handling.* 32 *contains the most advanced, patented C & L blow-torch improvements. It also has a red handle. Sure sign of satisfaction.*

ALL in Favor of Adjustable Wrenches say, "AYE"

Handy Men

Why rummage around trying to find an open end wrench to fit that nut? Just grab your B & C Adjustable — flick the adjusting screw 'til the jaws fit snug and you've a grip that's more dependable and you've loosened the nut in half the time.

Shop Men

Idle seconds become idle hours when figured on a month's work. Increase your production with this fast-working wrench.

Farmers

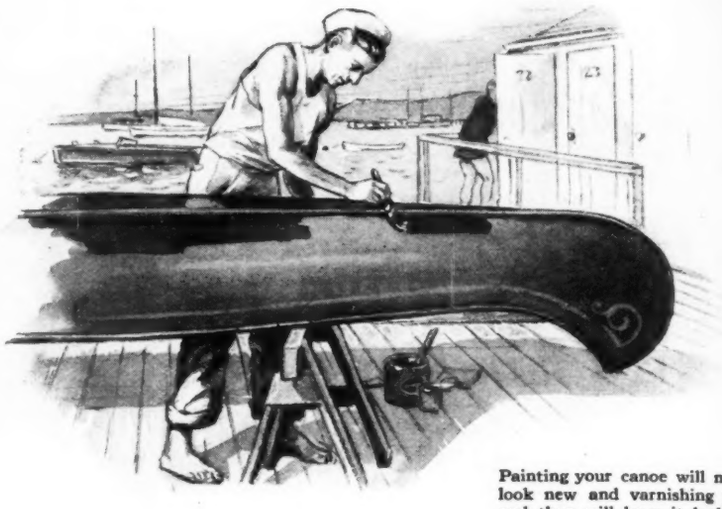
One wrench that can be adjusted to fit most of the nut tightening jobs on your equipment. A B & C will save your time and temper.

The Motion is Carried—a Unanimous Vote for

B & C
Adjustable "S" Nut Wrench

Sold by the Best Hardware Stores Everywhere

BEMIS & CALL
124 Main Street
SPRINGFIELD, MASS.



Painting your canoe will make it look new and varnishing it now and then will keep it looking so

Refinishing a Canvas Canoe

Ways to Remove the Old Paint—Fillers —Color Coats—How to Apply Varnish

By J. V. Hazzard

WHEN your new canvas covered canoe came from the factory, it was shining with bright paint, varnish and burnished brass. A season's use took off some of the gloss, and at the end of the second year the old boat looked its age. Perhaps you gave her over to the local canoe painter, who, to your astonishment, turned out a pretty job in forty-eight hours. Since then, no doubt, you have repeated the treatment at intervals. And now every time you lift an end of the canoe, she seems to weigh a ton.

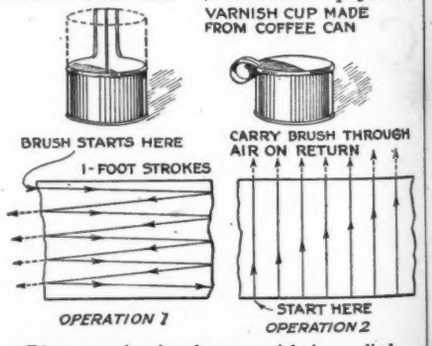
The fact is that nearly all commercial canoe painters it has been my fortune to meet, fail to remove the old coats properly. A good many of them refuse to tackle the removal end of the job for any consideration, justifying their refusal by stating that you would enjoy neither waiting for them to remove the old coats nor paying their bill. So, if your canoe is to be painted as it should be, the probability is that you will be obliged to do it yourself.

Locating a suitable place to work is not as difficult as might be expected. I have painted canoes in the canoe house, where it was necessary to place them on high racks after each coat, and I have seen exceptionally fine jobs come out of dark basements and apparently impossible back yards. The best place, of course, is a clean, dry, light room with good ventilation.

Wash the canoe thoroughly inside and out with soap and water and rinse it well with clear water. To remove sand and lint from interior crevices, it will be necessary to use a sharpened stick. As soon as the interior has had ample opportunity to dry, it should be varnished, together with the seats and thwarts; these parts receive the wear and must be thoroughly hard before being used.

Here, truly, an ounce of prevention is worth a pound of cure, for if you have badly misused the interior of your canoe and are obliged to remove the old varnish to secure a presentable job, you are going to pay the fiddler double. The removal can best be accomplished with lye or paint remover. Either is difficult to apply because of the uneven surface and many angles. Then, too, either remover must be washed off thoroughly before any varnishing is done. The alternative is to paint the inside of the canoe something hardly to be thought of, as there is nothing uglier than a painted interior. A middle course would be the application of varnish stain of suitable shade.

In this connection, it is a good thing to remember that the interior of your canoe is viewed at close range, so if you are proud of your craft, as every good canoeman should be, do a workmanlike job of it, even at the expense of skinned knuckles and a burn or two. Two thin varnish coats are *(Continued on page 109)*



Diagrams showing how varnish is applied and a suggestion for making a varnish cup

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HARD WORK is *EASY* with Automatic Tools

There's not much pleasure in drilling a hole—not much fun in driving screws.

That is—there didn't *use* to be. Now there's a thrill of satisfaction in the clean, speedy work of the MILLERS FALLS automatic drill—in the "zip" with which the Millers Falls spiral ratchet screw driver drives that screw home.

Tools you take pride in do work you can be proud of! The MILLERS FALLS Catalog of good tools is yours for the asking.

MILLERS FALLS TOOLS SINCE 1868

The Best Dealers Sell MILLERS FALLS Tools.

MILLERS FALLS COMPANY

MILLERS FALLS, MASS.

New York—28 Warren St.

Chicago—9 So. Clinton St.

MAIL THE COUPON FOR YOUR CATALOG

MILLERS FALLS COMPANY
Millers Falls, Massachusetts

Please send free catalog of the complete MILLERS FALLS line of high grade tools, with additional information about automatic tools.

Name .....

Address .....

PS-528

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Complete Construction Set *for the* May flower

MATERIALS NEEDED

64	Dead eyes 1/4"	$.09	$5.76
31	Dead eyes 1/8"	.08	2.88
2	Anchors O.S.W.M. 2 3/4"	.50	1.00
1	Capstan 1/4"		1.00
3"	Laddering	.15	.45
6 doz.	Belaying Pins 1/8"	.20	1.20
2	Airports Pl. 1/8"	.07	.14
1 ball	Rigging No. 5		.50
1 ball	Rigging No. 40		.50
10 yd.	Rigging black	.05	.50
5 yd.	Rigging brown	.05	.25
1	HULL BLOCK MAYFLOWER		10.00
1	B/P MAYFLOWER		3.75
24	Blocks S. P. 1/4"	.06	1.44
12	Blocks S. P. 1/8"	.08	.96
12	Blocks D. P. 1/8"	.08	.96
6	Blocks D. P. 1/8"	.10	.60
10"	Spar material 1/2"		1.00
	Complete Set		**$32.89**

In the list above you will find all the essential fittings, including the wood for the hull and spars, needed for making the Mayflower. Just check the items you want and send with your remittance to Boucher, Inc.

Do not confuse Boucher Construction Set with ship model materials made by other people. Many of the greatest collectors of ship models in America are our customers. By using our parts and our materials you can build a model of the Mayflower worth $175 or more.

Send 25c for Model-Makers 92-Page Hand Book

This booklet—SCALE MODELS—has 92 pages of useful information for model makers. Contains history of steam engines, nautical terms, knots, hitches and splices commonly used on boats. Recommendations for finishing and painting model ships and hundreds of other ideas you will find useful.

Whatever type of ship—sail or steam—ancient or modern—you are building, or planning to build, you will find the booklet, SCALE MODELS, of tremendous help. Send 25c today for your beautifully illustrated copy. It will be sent you by return mail, postage prepaid.

Gentlemen:—Enclosed is 25c for which please send me immediately your 92-page illustrated booklet, SCALE MODELS.

Name.....

Address.....

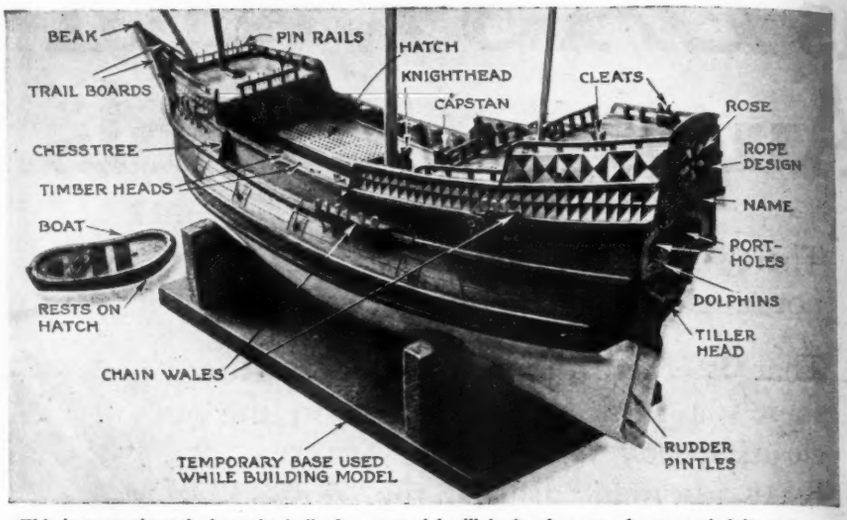
Headquarters for Model Makers for 22 Years

Boucher Inc

415 Madison Ave. Dept. M2 N. Y.

Our *Mayflower* Takes Shape

(*Continued from page 78*)



This is approximately how the hull of your model will look when you have carried it as far as described in the accompanying article. Compare this view carefully with the deck and sheer plans

cutwater, the curl comes to the beam at the forecastle and the trail board (middle piece) straddles the deck-line wale.

Before putting them on, fit and fix an upright skid of 1/8 in. square wood to the fore edge of the forecastle. Then glue and screw, or rivet, the ends of the headrails to the cutwater immediately back of its curl. Glue and nail the trail board in position and fasten the curl of the rail to the skid and the lower rail to the hull.

Fasten a bar across, to lie on the cutwater close up to the knee, and another in line with the second upright from the end.

To fill in the space between the trail boards, three gratings are fitted, although these may be omitted. The two after ones lie on the upper wale and the first cross batten. They fit against the trail boards, but are a full 1/4 in. clear of the cutwater, to allow of the passing of the gammoning (bowsprit lashing). The forward grating butts up to these and lies also on the forward batten. Fit them with cardboard before cutting. The gratings might be made from thick, stiff cardboard, but there is an easy way of making them of wood—and this also applies to the main hatch.

Cut a piece of thin three-ply to the outside shape and mark it off evenly in squares, with a wider rim. With a sharp knife cut through the top layer of the wood, longitudinally, with the grain; with the point of the knife pick out alternate strips; then use a fret saw to cut right through the crosslines, from rim to rim. Glue the strips you have taken out (which should have been marked for position) and put them back in their slots; sandpaper smooth, and you will have a fine grating.

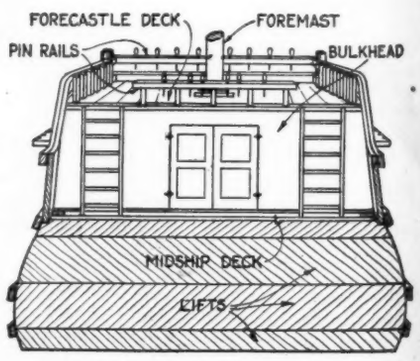
Across the top of both rails and the fourth upright nail and glue an oblong pinrail, 1/8 in. wide, with holes for nine belaying pins.

Fine nailing, such as this, is best done with 1/2 in. long bank pins. A hole must be bored to start them right and they must be hammered very gently. Where the round head of the pin would look bad, it should be first filed flat, or if it is cut off before it is driven right home, the hammering will form a slight burr, which is sometimes a sufficient head. When gluing or nailing is mentioned, the part should always be both glued and nailed. For gluing small parts, liquid glue will serve, but to keep out the damp, always subsequently cover such joints if possible with varnish or paint.

Chain wales will be wanted at the fore, main and mizzen to spread the rigging. These should be on the hull wales, but it is easier to make them wider and fasten them just above the latter wales.

Their length and positions can be seen in the rigging plan (Blueprint No. 85). They are 5/16 in. wide, and along their outer edges have deep notches to take the chain plates, holding the deadeyes down. Fasten them firmly.

On either bow, just abaft the headrails, fasten blocks of wood 1/8 by 5/16 by 7/16 in., and through them bore into the hull 1/8-in. holes. These are the hawse pipes for (*Continued on page 113*)



Sectional view showing the construction of the hull looking forward toward the forecastle. The doors are carved on thin hardwood

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ATKINS SILVER STEEL SAWS

HIS FIRST LESSON WITH ATKINS SILVER STEEL SAWS

In Your Home Workshop

Good work requires good tools. Genuine ATKINS "Silver Steel" Saws will save you many times their cost in time and material. "Silver Steel" makes them hold their edge longer. "Atkins Taper Grinding" makes sawing faster and easier with precision that saves planing and finishing. Ask *YOUR* hardware dealer to show you ATKINS Saws and Tools.

It will pay you to use the coupon below and get the REAL facts on saws and sawing. "Saws in the Home" has suggestions for articles you can make, "Saw Sense" tells about saws and their care—both FREE.

ATKINS SAWS and TOOLS for YOUR Home Workshop

Atkins No. 53 Hand Saw
Atkins No. 53 Rip Saw
Atkins No. 51 Panel Saw
Atkins Coping Saw
Atkins Compass Saw
Atkins No. 2 Hack Saw
Atkins Nest of Saws
"Silver Steel" Hack Saw Blades
Atkins Hack Saw Frames
Atkins Handy Saw
Atkins Scraper Blades
Atkins Slim Taper Files
Atkins Mill B. Files
Atkins Saw Set

"A PERFECT SAW FOR EVERY PURPOSE" Ⓢ

E. C. ATKINS & COMPANY

Established 1857 *Home Office and Factory* The Silver Steel Saw People

402 South Illinois Street, INDIANAPOLIS, INDIANA

Canadian Factory: Hamilton, Ontario Machine Knife Factory: Lancaster, N. Y.

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At all first-class hardware jobbers and dealers the world over

Get these Books—FREE!

E. C. Atkins & Co.,
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Please send Free Books "Saw Sense" and "Saws in the Home"

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Engineers' Pattern
12 openings, 5/16 to 1"
No duplicates.

Every car owner needs these wrenches

Williams' "Superrenches" make even the most awkward, close-quarters job much easier. Forged from tough Chrome-Molybdenum steel, they are much lighter than ordinary wrenches—yet far stronger. And their thin heads with narrow, pointed jaws get in and grip where no heavier wrench *could* go.

"Superrench" Sets provide efficient service in the minimum number of tools. Every car-owner needs a Set. Write for booklet. And remember—

Every "Superrench" is Guaranteed Against Breakage.

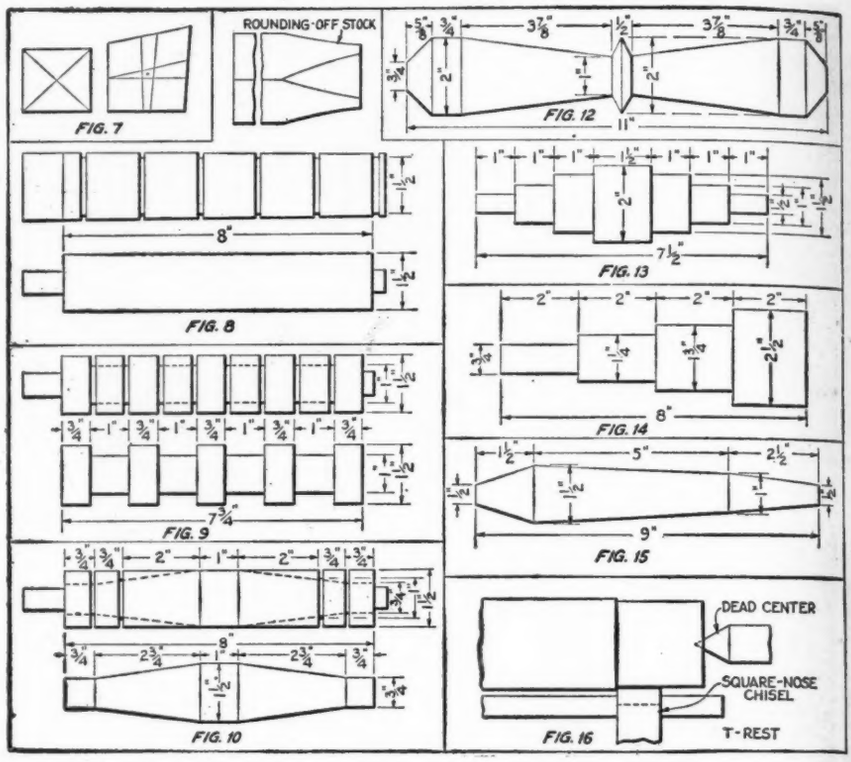
J. H. WILLIAMS & CO.
"The Wrench People"
246 Vulcan St., Buffalo, N.Y.

WILLIAMS
DROP-FORGED TOOLS

Obstruction Pattern
10 openings, 3/4 to 1/8"
No duplicates.

Wood Turning for Beginners

(*Continued from page 81*)



Steps in centering the work and in turning cylinders and various other forms that are derived from the cylinder. In articles to follow, Mr. Hjorth will give designs for turned furniture

in the left. Cut into the wood with the parting tool while holding the calipers in the groove being cut until the calipers slip over the cylinder (Fig. 4). Make several cuts about 1 in. apart.

Smooth the cylinder with a square-nose turning chisel or an ordinary firmer chisel with a long blade. Hold the beveled side down and place the chisel flat on the T-rest (Figs. 5 and 16). Cut to the bottom of the grooves made with the parting tool until the cylinder is smooth and of the same diameter throughout. Test it by placing a straightedge along it.

SQUARE the end running on the dead center with the parting tool. If the hole left by the dead center will be unsightly in the finished object, this cut should be made about ½ in. from the end. Cut down to about ¼ in. on both ends. When the piece is removed from the lathe, the ends can then be sawed off with a back saw and smoothed with a chisel. The ends can also be squared with a skew chisel; it is placed on its side, flat on the T-rest, and the cutting is done with the toe, where the cutting edge makes an acute angle with the side (Fig. 6). Test for squareness by holding the side of the tool against the end (Fig. 3). Measure the length and make a cut on the other end.

To make shoulder cuts, proceed as follows: You may use the cylinder just turned or make a similar one, laying it out according to Fig. 9. Place a rule on it and mark all the points without moving the rule. Steady the pencil on the T-rest and press its point against one of the marks on the cylinder. Revolve the cone pulley with the left hand so that the pencil scores a line all around the cylinder. Repeat at all the other points.

Set the calipers to a little more than 1 in. in diameter and cut with the parting tool on the inside of the lines indicating the 1-in. divisions (Fig. 4). Leave a little stock for finishing.

Remove the wood between the cuts with the square-nose chisel, making that part of the cylinder 1 in. in diameter. Finish the shoulder cuts with the parting tool or skew chisel. Cut off the projections on both ends.

Two other problems are suggested in Figs. 13 and 14. Any lumber may be used and the dimensions changed as necessary. However, start out with a drawing and definite dimensions. See how closely you are able to follow them. A good plan is to make two turned pieces from each drawing and compare them. Lay off the measurements as explained before. Cut down to the proper diameters with the parting tool, but allow 1/16 in. more than the diameters needed on the taper cuts. Finish the square sections on the ends with a square-nose chisel.

With a ½-in. gouge or a round-nose chisel, remove the wood on the tapers almost down to the cuts made by the parting tool. The round-nose chisel, like the other scraping tools, should be held flat on the tool rest with the bevel down. Finish the tapers with a square-nose chisel, a diamond-point chisel or a skew chisel as shown in the remaining drawings.

Two supplementary drawings (Figs. 12 and 15) are given for practice purposes.

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Novel Pipe Rack Has Japanese Lines

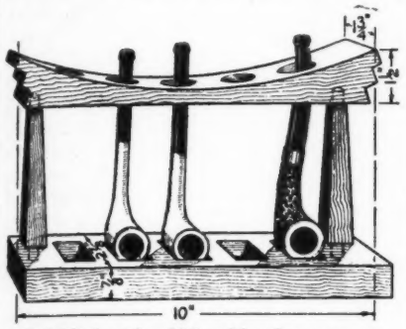
By W. L. Faurot

THE famous Miyajima arch in the Inland Sea provided the Japanese design theme for the pipe rack illustrated.

For the top, a piece of soft pine 1¾ by 1½ by 10 in. is used. Before the curved side is cut, five holes 1 in. in diameter are bored through it, the center one first; the others are spaced 1½ in. from center to center. The base is ⅞ by 2⅞ by 10 in.

After the top piece has been cut out, it is placed upon the base with the ends flush so that the pipe bowl recesses can be located. They are 1⅛ by 2⅛ in. and ½ in. deep and are placed ¼ in. nearer to the front edge of the base than the other because of the offset of the pipes.

At a point 1 in. in from each end and ⅞ in. from the rear edge of the base, drill a



Red, black and gold brushing lacquers are used to decorate this attractive pipe rack

⅜-in. hole ¼ in. deep to receive the upright posts. On the flat side of the arch bore corresponding holes 1 in. in from each end and centered.

Make two uprights 4½ in. long tapered from 1 in. to ½ in. and squared. Cut each end down to a dowel ⅜ in. in diameter and ¼ in. long. To insure a tight fit, make a fine saw cut in each dowel, cut two small wedges 3/16 in. in length and a little thicker than the width of the saw cut, apply glue to the dowels, wedges and holes, and drive all the parts tightly together.

Allow the glue to set for a day, then sandpaper the rack thoroughly and apply a priming coat suitable for use under lacquer. This in turn should dry a day and be sandpapered. Brushing lacquer then is applied. Red for the top and base and black for the upright posts look well. A few touches of gold striped on are effective as a decoration. Glue a piece of thin felt or other suitable cloth to the bottom.

WHEN the summer moisture swells the drawers of a dresser, sideboard or cabinet, the handy man of the house usually can make them work smoothly without much trouble. The edges of the drawer openings and the parts of the drawer that stick may be rubbed with a piece of paraffin wax or wax candle; even a piece of hard soap will answer. Usually this will relieve all but the worst places, and these may be touched lightly and cautiously with a plane.—C.K.

No other
Push Drill like a
"YANKEE"

"YANKEE"
on the tool is your protection against imitations

Eight Drill Points 1-16 to 11-64 inch in handle of each Drill. And every single one of them has been given the "Yankee" individual test.

YOUR guarantee that you will get what you want in a Push Drill is the name "YANKEE". Perfect action—smooth as a piston; just play to bore holes; you get speed.

The "Yankee" design is right—recognized the world over. Built to last—each "Yankee" part is made only of the finest material and finished with "Yankee" care and precision. So little pressure is needed that you can hardly realize that the point is actually turning, that it is biting its way quickly into your work.

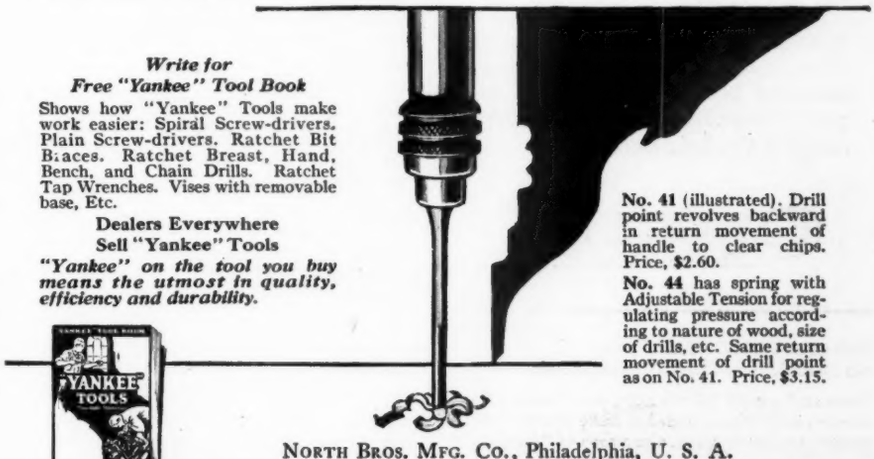
This "Yankee" Push Drill saves you time and labor. It keeps its smoothness and efficiency for years. Because it stands up in hard service, it is the most economical push drill you can buy.

Every "Yankee" Tool is sure to be right—because of the "Yankee" inspection and test in the factory before tool goes to your dealer. Make sure you get the genuine—look for "YANKEE" on the tool that you buy.

Write for
Free "Yankee" Tool Book
Shows how "Yankee" Tools make work easier: Spiral Screw-drivers. Plain Screw-drivers. Ratchet Bit Braces. Ratchet Breast, Hand, Bench, and Chain Drills. Ratchet Tap Wrenches. Vises with removable base, Etc.

Dealers Everywhere Sell "Yankee" Tools

"Yankee" on the tool you buy means the utmost in quality, efficiency and durability.



No. 41 (illustrated). Drill point revolves backward in return movement of handle to clear chips. Price, $2.60.

No. 44 has spring with Adjustable Tension for regulating pressure according to nature of wood, size of drills, etc. Same return movement of drill point as on No. 41. Price, $3.15.

NORTH BROS. MFG. CO., Philadelphia, U. S. A.

"YANKEE" TOOLS
Make Better Mechanics

You can make one yourself—in your attic—with a few hours' spare time

A home-made NURSERY!

ONCE this was a dusty old attic. Sweltering heat in summer and bitter cold winds in winter made the space fit only for old trunks, furniture and rubbish.

With a few big strong boards of Celotex, a few hours' spare time, and a little ingenuity, this comfortable, charming nursery was built by the owner.

Any man or boy can make such magic transformations of old waste spaces if Celotex is used.

Celotex boards are so easy to apply! You need only a hammer, nails and saw. Celotex weighs only half as much as wood, yet when used in walls, has more bracing strength. It is without grain; hence, it will not warp, crack or split.

And Celotex *insulates*—stops heat, cold and dampness. It makes rooms warm in winter and cool in summer. It is the only insulation made from cane fibres. This board combines to a remarkable degree extreme lightness with great strength and the ability to stop heat, cold and dampness.

All reliable lumber dealers can supply Celotex. Fill in and mail the coupon and we will send you FREE, two interesting, illustrated books. The Celotex Company, Chicago, Ill. *In Canada:* Alexander Murray & Co., Ltd., Montreal.

CELOTEX
INSULATING LUMBER

Pop. Sci.—5-28

THE CELOTEX COMPANY
645 North Michigan Ave., Chicago, Illinois

Please send me FREE your 40-page illustrated book showing how Celotex is used to make insulated attics, garages, sun-porches, etc., also a copy of "Artistic and Useful Things *You* Can Make at Home with Celotex."

Name.....

Address.....

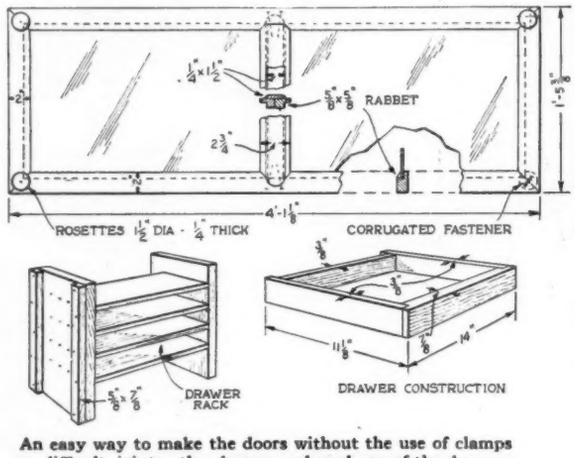
For All a Boy's Treasures

(*Continued from page 79*)

top shelf, and add a 1½-in. filler at the ends of the openings for the bottom drawer.

Get out the sidepieces for your drawers about ⅜ in. wider than the face pieces. Lay the face piece down, place a small piece ¼ in. thick across the end, and mark the depth of the cut for the rabbets which are to receive the sidepieces. Stand the face piece on end, shove a sidepiece against it, and mark the depth of the cut. Then square a line through the mark.

Put the face piece in the miter box and cut to the line. Stand it on end, put a long-bladed knife on the mark across the end, and hit the knife a tap with a hammer. The piece will fly out, leaving the rabbet to be dressed smooth with a file.



An easy way to make the doors without the use of clamps or difficult joints; the drawer rack and one of the drawers

NAIL the sidepieces on the face piece, letting them project 3/16 in. above and below. Square over from the face piece and dress the sides to the proper width with a block plane. Get out each back piece ⅛ in. less in width than the sides. Let it drop back 1 in. from the end of the sidepieces. Square up the drawer and place it on the board to be used for the bottom. Mark around the inside edge and saw out; then slip it up from the bottom, push it to the height of the lower edge of the back, and nail. Toenail the bottom to the face piece on the bottom side. Drive a 1-in. brad in the center of each face piece where the knob is to go and leave the knob off until after the cabinet has been stained and varnished.

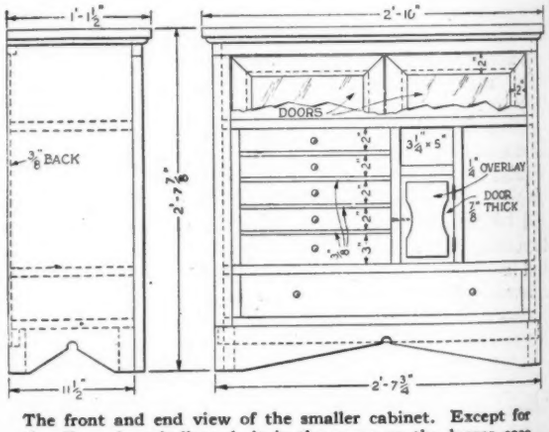
Check the length and width of the case and make the doors a little smaller than the opening. A good place to assemble a door is on a smooth concrete walk or floor. The doors may be constructed in the conventional way, but in the absence of a bench, clamps and adequate equipment, the following method will be found simpler in evey way:

After you have cut the miters at the ends of the stiles (sidepieces) and top and bottom rails, lay them on a smooth, true surface to see if the corners fit. Test them with a square; then fasten with glue, corrugated fasteners and brads as shown.

RIP some of the door frame material so that there is only ¾ in. of wood back of the rabbet, and nail together to give two pieces with a rabbet on each edge. Cut these to a snug fit between the back of the rabbets on the door. Put them in the miter box, rabbet side up, and miter the corners as shown. Then, with the door face side up, place them just halfway between the ends and mark for a square cut through the lip of the rabbet of the stiles. After sawing through the lip, trim out with a pocketknife. Let the crosspiece slide into this square cut until stopped by the lip of its rabbet. Mark where the crosspiece is mitered at the corners, take out the crosspiece and cut corresponding corners off the door stiles, finishing with a file so as to get a tight fit.

Slip in the crosspiece and put a thin piece of wood on each side, catch these pieces with a clamp and drive two sixpenny nails from each edge. An ornamental piece ¼ by 1½ in., and 2 in. shorter than the width of the door, may be nailed on the center rail, as shown, and thin rosettes glued and nailed on the corners to hide the corrugated fasteners.

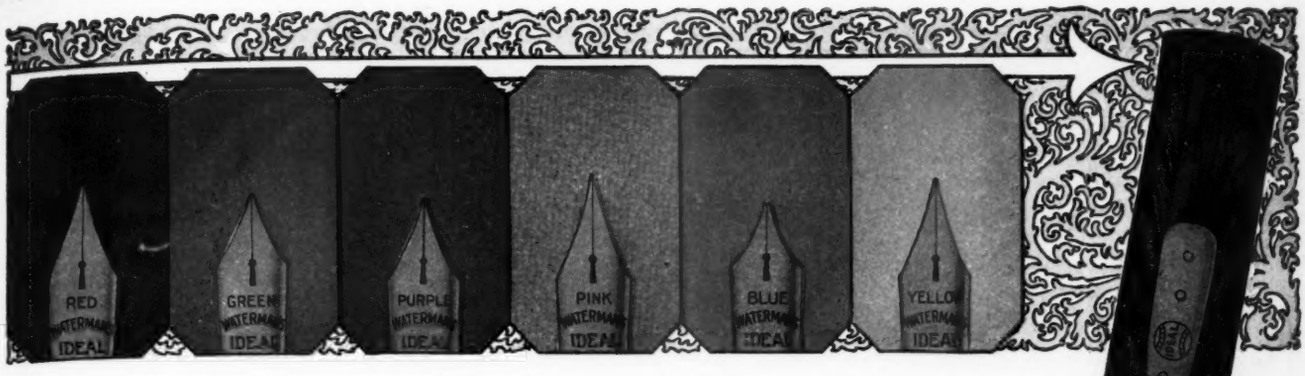
Where the larger nails have been used countersink deeply and plug with wood after touching the ends of the plugs in glue. Let the plugs stand overnight and cut them smooth. Fill all brad holes with water putty, plastic wood filler, or glue and whiting colored with the stain you intend to use. Sandpaper all exposed surfaces.



The front and end view of the smaller cabinet. Except for the dimensions indicated, it is the same as the larger case

A dark stain will hide imperfections best, so dark (*Continued on page 97*)

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.



PICK YOUR PEN POINT BY COLOR

The simplest, safest, surest way to get permanent pen satisfaction is to pick your pen point by color.

Waterman's Number Seven

with its identifying color band offers the quickest, most reliable guide to pen point selection

The following colors on holders tell the story of pen point character. Look for them on Waterman's Number Seven.

Red—STANDARD—Suits most writers. A splendid correspondence point. Medium flexibility. For home and general use.

Green—RIGID—Tempered to armor-plate hardness. Will not shade even under heavy pressure. Unequaled for manifolding. The salesman's friend.

Purple—STIFF; FINE—Writes without pressure. Makes a thin, clear line and small figures with unerring accuracy. Popular with accountants.

Pink—FLEXIBLE; FINE—As resilient as a watch-spring. Fine, tapered point; ground fine to shade at any angle. Loved by stenographers.

Blue—BLUNT—An improved stub point. This point makes a broad line. May be held in any position. Liked by rapid writers.

Yellow—ROUNDED—A different pen point. The tip is ball shape. Makes a heavy, characteristic line without pressure. Suits left-handed writers.

Merchants who sell Waterman's will be glad to let you try all six points. Do this and select the one that suits you best.

When you buy a Waterman's you buy perpetual pen service.

Guaranteed since 1883 and until 1983—100 years of pen service

L. E. Waterman Company
191 Broadway, New York

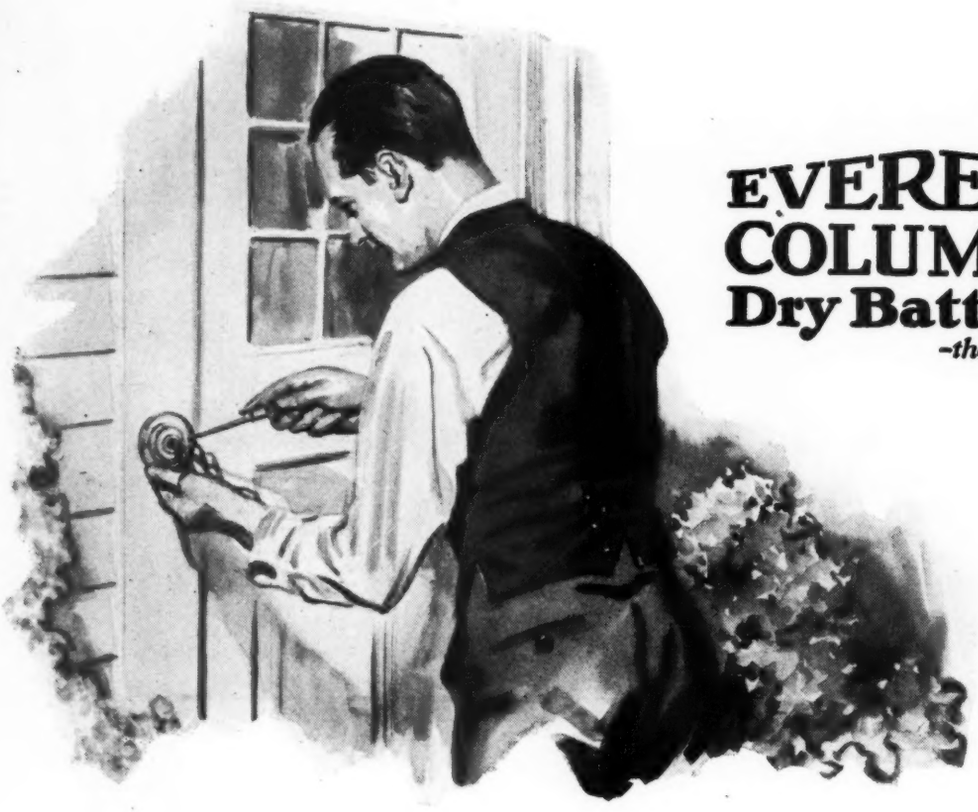
CHICAGO BOSTON SAN FRANCISCO MONTREAL

$7.00

Number Seven

Beautiful, resilient *Ripple* stainless rubber holder. Made with protective lip-guard and an unequaled patented filling device.

Waterman's



EVEREADY COLUMBIA Dry Batteries

-they last longer

When you fix the doorbell

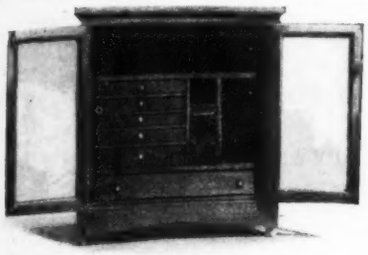
WHEN you fix your own or somebody else's doorbell or buzzer, put in Eveready Columbia Dry Batteries. They are the ones that last longer and, by their reliability, protect the operation of the things they operate. Electrical engineers, graduates of the big technical schools, know and use and recommend them. Big business houses that count the pennies, buy them. Take a leaf from the experience of the engineers and the business-men and you'll be protecting your own reputation as a fixer. Buy Eveready Columbias.

NATIONAL CARBON CO., INC.
New York UCC San Francisco
Unit of Union Carbide and Carbon Corporation

FOR RADIO: The only way we can beat the Eveready Columbia is to make a special cell for one specific use. That's what we have done in the Eveready Dry Cell Radio "A," No. 7111. Made specifically for use on radio sets using dry cell tubes, and superior in that service.

For All a Boy's Treasures

(Continued from page 96)



This is the cabinet Mr. Jeffries made for a boy interested in geology and chemistry

mahogany is recommended. It is best, I think, to stain the partitions, inside faces of the sidepieces, and inside surface of the back before assembling them. The back, being thin, will warp easily, so nail on each piece as fast as stained.

Put the stain on with a brush or a soft rag made into a ball. To get an even finish with no laps, rub lengthwise with a rag before the stain dries. Give one coat of thin shellac, rub down with very fine steel wool or sandpaper, and finish with wax.

Hang the doors, put on any type of catch or lock and drawer knobs you prefer and fasten a small bolt or elbow catch back of the left-hand door at the top.

Fasten the glass in the doors with 3/8 by 3/8 in. strips, using brass nails with small round heads (escutcheon pins). Stain and finish the strips beforehand.

In the smaller cabinet the same methods were followed. Note that a nail was used as a secret lock for the little door and also that filler blocks were placed inside the lower corners and bored for casters.

Lumber Bill for Large Cabinet

No. Pcs.	T.	W.	L.	Part
2	⅞	11½	57 ⅝	Sides
1	⅞	11⅛	44	Partition
3	⅞	11⅛	36	Shelves
3	⅞	11⅛	24	"
1	⅞	4	10 ft.	Top and bottom piece and drawer front
1	⅞	1½	16 ft.	Face pieces and other use
2	⅞	11⅛	12½	Rack ends
1	⅞	3	24	Back of closet
1	⅞	3	14	Drawer face
4	⅞	2	14	" faces
1	¾	....	36	Quarter round for top
2	⅞	2	16 ft.	Doors. Rabbet ⅝ by ⅝
4	⅝	9	50 ⅝	Back
5	⅝	11	14	Drawer bottoms
1	⅝	11	33	" bottom
4	⅝	11	14	Rack Partitions
1	⅝	4½	5 ft.	Drawer sides and ends
1	⅝	3½	16 ft.	" " " "
2	⅞	⅝	12½	Drawer rack
1	⅝	1½	42	Top fillet
1	¼	2	48	Door overlay

All dimensions are in inches except as otherwise noted. The ⅝ in. thick pieces can be cut from two boards 11 in. wide, 16 ft. long, and one board 11 in. wide, 6 ft. long.

WHITE LIBRARY paste may be made by mixing one third of a cup of laundry starch and two thirds of a cup of white flour with cold water to make a smooth paste and pouring it very slowly into a pint of boiling water, this must be stirred constantly and the boiling continued for about ten minutes. If the mixture appears to be too thick, it may be thinned with more water. While the paste is still hot, add a heaping teaspoon of salicylic acid and ten drops of cinnamon oil.—N. G. K.

1,000 Men Told Us

What men wanted in shaving cream. Now, before you buy, try what we've made for you —at our expense— for 10 days

GENTLEMEN:

Politicians know what to expect nationally when an election goes one way or another in the comparatively small state of Maine. And so, in merchandising, experience teaches that the opinion of 1000 men reflects the average viewpoint of millions.

So, when we decided to create a shaving cream, we asked 1000 men what they sought in shaving comfort and efficiency. Then we set out to meet their requirements.

They told us four things. We gave them five. Now we ask the courtesy of a test—based solely on merit—to prove *to yourself* the shaving delights we have discovered for you.

Just mail the coupon for a free 10-day test

Our laboratories for 65 years have specialized in fine soap products. One of our toilet soaps is a leader of the world. Others are used in countless homes and institutions everywhere.

With the four objectives we had set, we started our experiments. Time after time we got a fine shaving cream result, yet one or another of the things we sought was missing.

Finally, after the 129th experiment, success came. It was enthusiastically received by men everywhere. Today it is outstandingly the fastest selling shaving cream on the market.

These 5 important factors

1. Multiplies itself in lather 250 times.
2. Softens the beard in one minute.
3. Maintains its creamy fullness for 10 minutes on the face.
4. Strong bubbles hold the hairs erect for cutting.
5. Fine after-effects due to palm and olive oil content.

Now make the trial, please

No doubt your present shaving preparation suits you, yet there may be a better way. We've tried to find one for you, and will thank you to give it a test. Just send the coupon now.

THE PALMOLIVE-PEET COMPANY, CHICAGO, ILL.

To add the final touch to shaving luxury, we have created Palmolive After Shaving Talc—especially for men. Doesn't show. Leaves the skin smooth and fresh, and gives that well-groomed look. Try the sample we are sending free with the tube of Shaving Cream. There are new delights here for every man. Please let us prove them to you. Mail the coupon now.

3972

10 SHAVES FREE

and a can of Palmolive After Shaving Talc

Simply insert your name and address and mail to Dept. B-1488, Palmolive, 3702 Iron St., Chicago, Ill.

Residents of Wisconsin should address Palmolive, Milwaukee, Wis.

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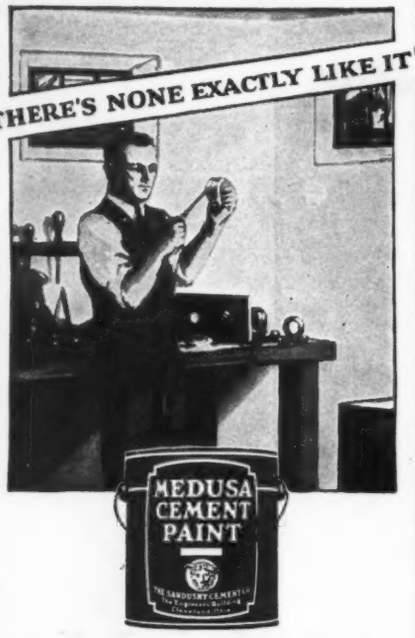
(Please print your name and address)



MEDUSA
CEMENT PAINT
Was Made for You

THE man who likes to have a spotless, clean, dry basement for his workshop or other purposes will find that Medusa Portland Cement Paint will give him a dense, hard, dampproof surface for the interior basement walls.

Critical as such men are apt to be of the quality of this product, we are confident that your most exacting requirement for a masonry wall covering will be anticipated in Medusa Portland Cement Paint.

We would like to tell you more about this product, explaining to you just why there is no other material on the market exactly like it. Fill in the coupon below—mark it for one of the two kinds of samples and send it in to us.

The SANDUSKY CEMENT *Co.*
1002 The Engineers' Bldg., Cleveland, O.
Manufacturers of Medusa Portland Cement Paint; Medusa White Portland Cement (plain and waterproofed); Medusa Gray Portland Cement (plain and waterproofed); and Medusa Integral Waterproofing.

THE SANDUSKY CEMENT COMPANY
1002 The Engineers' Bldg., Cleveland, Ohio
☐ Attached find dollar for large working sample.
☐ Send me free sample and literature.
Name .....
Street .....
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State .....
Hardware Dealer's Name .....
PS 58

THE SHIPSHAPE HOME

Puttying and Painting—Wall Fabrics—Floor Cracks—Chipped Enamel

By F. N. VANDERWALKER

FURNITURE, wood trim and all other surfaces to be finished in brushing lacquer usually require the use of putty in cracks and holes. The important thing to remember in this work is that ordinary types of oil and water putties do not adhere sufficiently well to lacquer to make it safe to use them. For more reasons than one, it is best to fill all defects before any lacquer is applied.

Lacquer has very little filling and leveling qualities; in fact, it appears to mirror and even emphasize surface defects. Consequently, the surface should be wellnigh perfect before any lacquer is applied. The foundation for lacquer enamel or clear lacquer may be either the usual prepared undercoaters for use with regular enamels, or white lead (or white lead and zinc in equal parts) thinned with turpentine or flatting oil.

All the puttying can be done after the first undercoat with a putty made from white lead-in-oil, dry whiting, dry color to tint, and a few drops of floor varnish or linseed oil. This putty should never, of course, be placed directly on new wood, for the oil would be absorbed by the wood and not sufficient would be left to bind the putty pigments together and assure adhesion tc the surface.

For use on the bare wood, however, a plastic wood putty can now be obtained at many paint and hardware stores. It resembles wood when dry and is especially useful on pieces of furniture or novelties that are to be finished in lacquer alone without any undercoats such as those just mentioned.

EXCEPT for the first coat on new wood or plaster, no oil should be used in undercoats or surfaces finished with lacquer. Furthermore, the undercoats, if of the types mentioned, should be given ample time to dry. As a rule the lacquer ought not to go on until the finished undercoats have had at least a week to dry hard; otherwise the lacquer may dissolve and lift the undercoats.

There are some special lacquer resisting undercoaters made now on an oil base and also some on a lacquer base. These dry more rapidly than old standard undercoaters and are better.

If some holes or cracks are overlooked until after a coat of lacquer has been applied, fill them with a lacquer putty made by mixing a little lacquer with some dry whiting.

Repairing Wall Fabrics

CEILINGS are bound to get wet occasionally from leaking roofs or plumbing, and side walls are subject to discoloration from similar causes or leaks from windows. When such surfaces are covered with canvas or other fabrics, you are apt to find the material has pulled away in bags perhaps a yard in area.

Before repainting the fabric you must paste it back, which is a problem when the bags have occurred in the center of wide strips. Here is the way to do it: Take a sharp knife and, placing a yardstick or rule on the surface, cut it in two directions in the shape of the letter "T" in the center of the bag. Brush off any loose, dry paste, and with a small brush apply a new coat of thick paste to the plaster, working it well under the fabric. Press the fabric back on the wall and smooth it over with any kind of a stiff brush; a clean shoe brush will do. Wipe off any paste that oozes out of the seams.

The paste can be made by mixing a little wheat or rye flour with a very little water, breaking up the lumps with your fingers, pouring a little boiling water on—just enough to cover the paste—and covering up the pot to let the paste cook in its own steam. When cool it is ready to use—rather thick.

If the fabric is a thick burlap, or if you do not work the seams back to a close, tight fit, it will be necessary to fill the joints with putty. A small spatula knife is a good tool for this small job, because you do not want to spread the soft putty on the fabric around the seams. A good putty is made from white lead paste and dry whiting, to which a very little japan drier or floor varnish is added to make it smooth; have the mixture thick. This can be colored to suit with dry color or colors ground in oil. After filling the seams, stipple them by pounding the wet putty with any dry, stiff brush. A whisk broom will do. This to make the smooth putty look rough like the fabric.

Filling Floor Cracks

WOOD floors shrink in time, especially in buildings that are kept hot and dry all through the winter. Softwoods are apt to shrink more than hardwoods. The cracks are often so large that a good job of refinishing the floors cannot be done until a filler has been applied. Filling the cracks also makes the floors easier to keep clean.

For a softwood floor that is to be painted, the first step is to scrape out the cracks with any sharp tool and remove all dirt. Then apply a coat of any good oil paint to the joints and force it well into them. After it is dry, the cracks may be filled with any one of two or three kinds of putty. A putty of excellent working qualities is mixed from white lead-in-oil paste, tinted with dry color like raw sienna, raw or burnt umber, and enough dry

(*Continued on page 100*)

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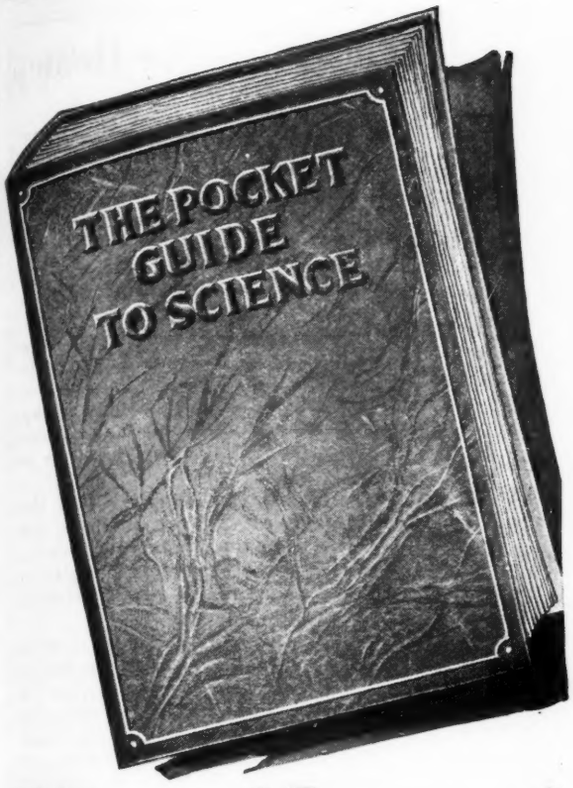

INTO THIS one brilliant book of 280 pages have been condensed the outstanding facts that scientists have discovered since Aristotle, the father of science, dissected a frog to see what made its heart beat.

How often have you wanted to know about the wonderful discoveries in science that have so changed the world we live in . . . the secret of radium . . . the romance of the atom . . . the origin of the earth!

Or you may have wanted to know why glass is transparent . . . how fireflies produce light . . . why the grass is green . . . if radio waves move in a straight line?

All of these questions, and hundreds of others, have now been answered, for the first time, in one book—THE POCKET GUIDE TO SCIENCE.

All that you probably will ever want to know about science is told in this one book that will fit in your pocket or grace a library table. The curiosity-satisfying facts about the world we live in are made instantly available to you in simple question-and-answer form in THE POCKET GUIDE TO SCIENCE.

Your Name in Gold
—on this Wonderful Book

YOU are assured of the accuracy of the answers in THE POCKET GUIDE TO SCIENCE because it has been edited by Dr. E. E. Free, the distinguished author of "The Story of Man and His World." Dr. Free has a remarkable genius for condensing the known facts about scientific questions into vivid, easily remembered paragraphs.

SPECIAL OFFER

THE POCKET GUIDE TO SCIENCE is not for sale. It is offered to you *without one penny extra cost*, with a 14 months' subscription to POPULAR SCIENCE MONTHLY.

In THE POCKET GUIDE TO SCIENCE you get full information of all that the scientists have discovered up to the summer of 1924.

POPULAR SCIENCE MONTHLY "carries on" where THE POCKET GUIDE TO SCIENCE leaves off. The POCKET GUIDE gives you all the information up to right now—POPULAR SCIENCE MONTHLY will give you all the important, interesting and new discoveries of science for the next 14 months.

In every issue of POPULAR SCIENCE MONTHLY are a dozen or more important articles that explain and picture the most fascinating and significant new developments, discoveries, and undertakings in exploration, in engineering, in health, in electricity, in medicine, and in every branch of science.

And there are also, in every issue, a hundred or more articles describing the important new inventions in every branch of mechanical activity—page after page filled with photographs and descriptions that show you how you can save money in the shop, around your car, in your store, office and home.

But all this is only part of the contents of one issue of the amazing POPULAR SCIENCE MONTHLY. It takes over 300 articles and pictures every month to tell the readers of POPULAR SCIENCE MONTHLY all that has happened in the scientific, radio, mechanical, and automotive fields.

A Few of the Hundreds of Questions Answered in the POCKET GUIDE TO SCIENCE

Why does static interfere with radio messages?
What gland makes people grow tall or keeps them short?
Why do we grow old?
What is the safest stimulant?
What is the function of the liver?
Why are tears salt?
Can energy be destroyed?
Why can't you skate on glass if it is smoother than ice?
How do self-winding clocks work?
Why does an iron ship float?
Can we see atoms with a microscope?
What are electrons?
Is electricity a form of matter?
What is a crystal?
How large is the universe?
Why do the stars twinkle?
How do we know what the stars are made of?
Is the inside of the earth molten?
What is an electric spark?
What makes the noise of thunder?

Your Name in Gold

We will stamp your name in 22-carat gold on the cover of THE POCKET GUIDE TO SCIENCE *at no extra cost to you* if you use the coupon below immediately.

You are offered a 14 months' subscription to POPULAR SCIENCE MONTHLY (regular price if bought by the month would be $3.50) with THE POCKET GUIDE TO SCIENCE—all for $2.95, plus the few cents' postage. If you are already a subscriber to POPULAR SCIENCE MONTHLY we will be glad to extend your subscription 14 months if you accept this offer.

In using the coupon please PRINT your name

POPULAR SCIENCE MONTHLY, 250 Fourth Ave., New York

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I accept your offer of THE POCKET GUIDE TO SCIENCE and a 14 months' subscription to POPULAR SCIENCE MONTHLY. I will pay the postman $2.95, plus the few cents' postage when he delivers the POCKET GUIDE and the first issue of POPULAR SCIENCE MONTHLY. If the book and magazine are not fully satisfactory to me I will return them within 10 days and you are to promptly refund my full payment. Please stamp my name in gold.

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5-28

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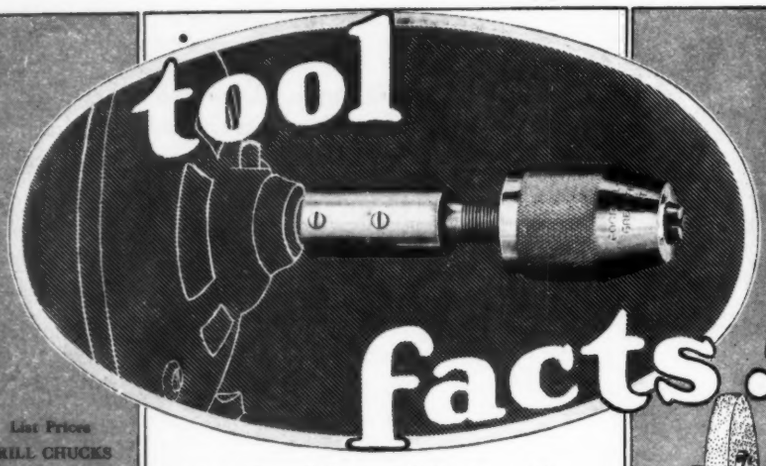


List Prices

DRILL CHUCKS
For 3/8 in. Shaft No. 757, each $2.50
For 1/2 in. Shaft No. 762, each $3.30
For 5/8 in. Shaft No. 861, each $4.00

SAW ARBORS AND BUFFING SPINDLES
For 1/2 in. Shaft No. 762, each $3.30
For 5/8 in. Shaft No. 862, each $4.00

BUFFING SPINDLES
For 3/8 in. Shaft No. 759, each $1.10 With R.H. Threads
No. 760, each $1.10 With L.H. Threads

The Mark of a Complete Line of Super-Performance Electric Drills

You Can Make a Machine Shop of Your Small Motor!

You can greatly expand its use, and much more easily do many of those odd jobs which you have heretofore found difficult.

Take drilling for instance. With a Drill Chuck, as illustrated above, and of the proper size to fit the shaft of your motor, you can convert it into a convenient and dependable bench drill.

The Combination Saw Arbor and Buffing Spindle provides a means of attaching a grinding wheel or saw, as illustrated in Figures 1 and 2; wire brushes and buffing wheels may also be used with this attachment.

For polishing and buffing only, Buffing Spindles are provided, and may be used as illustrated in Figures 3 and 4.

You'll of course appreciate that, with these attachments, much more rapid and accurate work can be done even by the amateur, and the skilled artisan finds that he can do many jobs, with such combinations, as well as he can with much more complete and expensive equipment.

The attachments, of the proper size, are easily fitted to the motor shaft and secured by set screws provided for the purpose. They are made with the care and precision characteristic of all Goodell-Pratt Tools, for many years famous for their uniformly high quality. Your local dealer probably has them in stock. If not, write us.

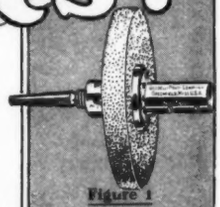


Figure 1
Illustration shows a No. 762 Combination Saw Arbor and Buffing Spindle fitted with a Grinding Wheel.

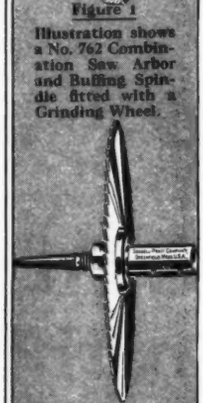


Figure 2
In this illustration a No. 762 Combination Saw Arbor and Buffing Spindle has been fitted with a saw.

Figure 3
Showing a No. 759 Buffing Spindle fitted with a wire brush.

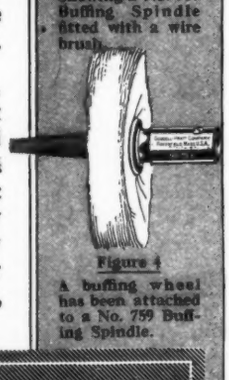


Figure 4
A buffing wheel has been attached to a No. 759 Buffing Spindle.

GOODELL-PRATT COMPANY Tool Smiths GREENFIELD, MASS. U.S.A.

GOODELL-PRATT
1500 GOOD TOOLS

The Shipshape Home

(Continued from page 98)

whiting to make a stiff composition about like bread dough. Add a few drops of floor varnish or boiled linseed oil and pound the putty with a mallet or baseball bat until fine and smooth. Knead well with your fingers and force the putty into the cracks with a putty knife. When the putty is dry, sandpaper any roughness about the cracks.

When the cracks are very large, some prefer to use a cabinetmaker's putty made by mixing any dry, fine sawdust with about an equal amount of dry whiting and adding cabinetmaker's glue or any good quality glue dissolved in water.

Maple floors can be filled with the same kind of putty, as can oak floors that pull away from the tile or brick hearth. Of course, if the shrinkage amounts to ½ in. or more, it is best to cut a strip of oak and glue it in the crack.

If an old floor with the wood worn into ridges is to be painted, sandpaper it down as smoothly as possible, apply a coat of paint, and glaze it over when dry with soft putty. Take the lead and whiting putty mentioned and add to it enough japan drier to make it work out smoothly. Use a broad glazing knife, which is like a putty knife but has a very wide blade that is more flexible. Apply the putty, smooth well and let it dry hard. Then sandpaper before painting.

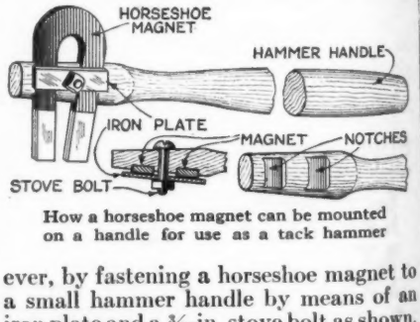
Chipped Fixtures

WHEN white vitreous enamel is chipped from a sink, lavatory or bathtub, the defect is often not sufficient to justify buying a new fixture, yet the black iron spot is an eyesore. A good way to fill these chipped places is to clean them thoroughly with a sharp tool and a cloth wet with alcohol or turpentine and touch them up with white brushing lacquer enamel applied with a small camel's-hair brush. Two or three coats may be necessary.

More hints on the use of putties, fillers and cements will be given in a forthcoming issue by Mr. Vanderwalker.

Magnetic Tack Hammer

WHEN hanging draperies in a clubhouse, I needed a magnetic tack hammer, but could not obtain one in any near-by hardware store. I made one, however, by fastening a horseshoe magnet to a small hammer handle by means of an iron plate and a 3/16-in. stove bolt as shown. The magnet cost fifteen cents, the handle five, and the bolt and plate five cents.—GEORGE H. MEEDER.



How a horseshoe magnet can be mounted on a handle for use as a tack hammer

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Blueprints for Your Home Workshop

ANY ONE of the blueprints listed below can be obtained for 25 cents. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available.

Popular Science Monthly
250 Fourth Avenue, New York

Send me the blueprint, or blueprints, I have underlined below, for which I inclose.....
.....dollars.....cents

No.	Title	Described in Issues of	Price
1.	Sewing Table	Feb., '22	25c
2.	Smoking Cabinet	*Mar., '22	25c
3.	End Table	*Apr., '22	25c
5.	Kitchen Cabinet	*May, '22	25c
9.	Arbor, Gate and Seats	July, '22	25c
10.	Porch Swing	Aug., '22	25c
11.	Bench and Tilt Table	Sept., '22	25c
13.	Tea Wagon	Nov., '22	25c
14.	Christmas Toys	*Dec., '22	25c
15.	Workshop Bench	Jan., '23	25c
17.	Cedar Chest	*Mar., '23	25c
18.	Phone Table and Stool	*Mar., '23	25c
19.	Grandfather's Clock	*Apr., '23	25c
20.	Flat Top Desk	*Apr., '23	25c
21.	Colonial Desk	*Apr., '23	25c
23.	One-Car Garage	*May, '23	25c
24.	Gateleg Table	June, '23	25c
25.	Canoe Sailing Outfit	July, '23	25c
26.	Baby's Crib and Pen	*Sept., '23	25c
27.	Kitchen-Cabinet Table	Oct., '23	25c
30.	Tool Cabinet, etc.	Jan., '24	25c
31.	Sewing Cabinets	Feb., '24	25c
33.	Dining Alcove	Apr., '24	25c
34.	Garden Trellises	May, '24	25c
37.	Simplified Bookcase	Dec., '24	25c
38.	Small Drop-Leaf Table	Jan., '25	25c
39.	Salem Chest of Drawers	Feb., '25	25c
41.	One-Tube Radio Set	May, '25	25c
42.	Three-Stage Amplifier	June, '25	25c
43.	Four-Tube Receiver	*July, '25	25c
44.	Pirate Ship Model—Hull	*Feb., '26	25c
45.	Pirate Ship—Details	Mar., '26	25c
46.	Galleon Model—Hull	May, '26	25c
47.	Galleon Model—Details	*June, '26	25c
48.	Sailing Yacht Model	*July, '26	25c
49.	Broom Cabinet	Aug., '26	25c
50.	Airplane Model (Flying)	Sept., '26	25c
51.	Clipper Ship Model—Hull	*Oct., '26	25c
52.	Clipper Model—Details	*Oct., '26	25c
53.	Clipper Model—Rigging	Nov., '26	25c
54.	Five-Tube Radio Set	Oct., '26	25c
55.	Five-Tube Set—Details	Oct., '26	25c
56.	Bird and Animal Toys	Dec., '26	25c
57.	*Constitution* Model—Hull	Jan., '27	25c
58.	*Constitution*—Rigging	Feb., '27	25c
59.	*Constitution*—Rigging	Mar., '27	25c
60.	Welsh Dresser	Mar., '27	25c
61.	Viking Ship Model—Hull	Apr., '27	25c
62.	Viking Ship—Details	Apr., '27	25c
63.	Toy Motor Boat—Hull	May, '27	25c
64.	Toy Motor Boat—Details	May, '27	25c
65.	Six Simple Block Puzzles	June, '27	25c
66.	Ship-Model Weather Vane	Aug., '27	25c
67.	Toy Model of Lindbergh's New York-to-Paris Plane	Aug., '27	25c
68.	Magazine-Rack Table and Book-Trough Table	Sept., '27	25c
69.	Flying Model (3 ft.) of Lindbergh's Monoplane	Oct., '27	25c
70.	Console Radio Cabinet	Nov., '27	25c
71.	Console Cabinet—Details	Nov., '27	25c
72.	Doll's House	Dec., '27	25c
73.	Doll's House Furniture	Dec., '27	25c
74.	*Santa Maria* Model—Hull	Dec., '27	25c
75.	*Santa Maria*—Rigging	Feb., '28	25c
76.	*Santa Maria*—Details	Jan., '28	25c
77.	Simple Pier Cabinet and Decorative Wall Shelves	Jan., '28	25c
78.	Simple Treasure Chests	Feb., '28	25c
79.	Electric Radio Set	Feb., '28	25c
80.	High Power Unit for Electric Radio Set	Mar., '28	25c
81.	Low Power Unit for Electric Radio Set	Apr., '28	25c
82.	Simple Single-Stick Airplane Model (30-in.)	Mar., '28	25c
83.	*Mayflower* Model—Hull	Apr., '28	25c
84.	*Mayflower*—Details	Apr., '28	25c
85.	*Mayflower*—Rigging	Apr., '28	25c
86.	Racing Airplane Model (35-in. twin-pusher type)	May, '28	25c

*Out of print.

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TRADE YALE MARK

Fine Builders' Hardware

YALE Builders' Locks and Hardware are made of carefully selected metals to assure the necessary strength and durability. All parts are accurately machined and fitted, insuring easy and firm operation. The key mechanism provides the highest form of lock protection and the beauty and durability of finish gives a distinctive elegance.

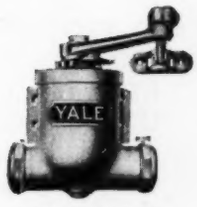
The whole ensemble of Yale Locks and Hardware is correct in design, staunchly built by master workmen and given a final thorough test and inspection to insure its accuracy. It is the best that skilled artisans can produce, and, yet, is moderate in price.

Yale Mono-Lock Set (*Vertical type*)

Yale Cylinder Front Door Set

Yale Bar Sash Lift

Yale Entrance Door Handle



Yale Door Closer

Yale Vertical Letter Box Plate

Yale Mono-Lock Set (*Horizontal type*)

Yale Bit Key Inside Door Set

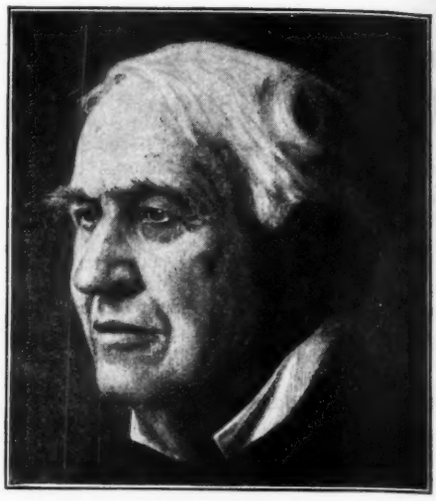
YALE MASTER-KEY SYSTEM

In the Yale Master-key System, all locks in manufacturing plants, office buildings, institutional buildings, hotels, the home, etc., are keyed differently, each lock having its own individual key which will not operate any other lock, but one master-key will unlock them all. A system of Yale Master-keyed Locks may be divided into groups, the locks of each group being controlled by a "sub-master-key", each lock in any group having its own key, differing from all others and all the locks in the entire system being controlled by a "grand master-key". Master-keying must be built into the locks during their construction. Send for complete story of the Yale Master-key System.

The Yale & Towne Mfg. Co.
Stamford, Conn., U. S. A.
Canadian Branch at St. Catharines, Ont.

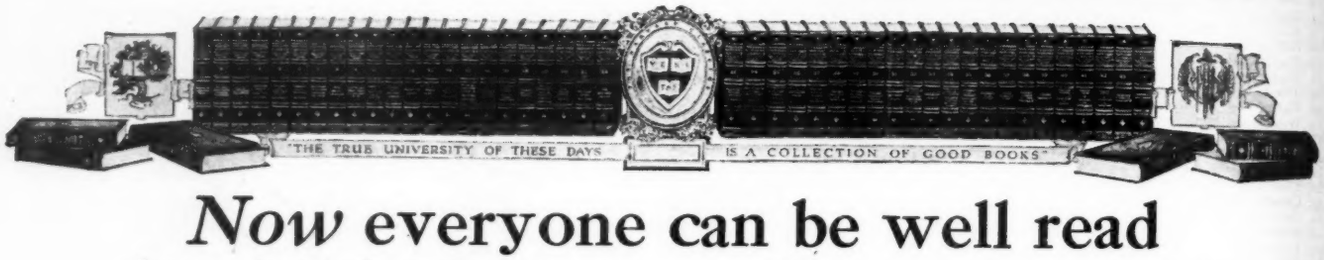
YALE MARKED IS YALE MADE

When Thomas Edison *groped in the dark*



IN 1859 Edison was a newsboy on the trains in and out of Detroit. He spent every hour he could spare in the public library "grappling bravely with a certain section, and trying to read it through consecutively, shelf by shelf, regardless of subject."

Admirable determination! Edison was destined to be well read, just as he was destined to become the greatest inventor of all time. But his early desire for fine reading was a blind groping in the dark. The books in a modern public library would take fifty lifetimes to read!



Now everyone can be well read

Just as America's greatest inventor brought light into the world through the great medium, electricity—America's greatest educator brought light to everyone through the medium of good reading. Dr. Charles W. Eliot, from his lifetime of study, selected the pure gold from the world's literature. Into a single set he assembled the essentials of a liberal education, the books that everyone must know to be well read. In the Five-Foot Shelf are the carefully selected writings of 302 immortal authors.

DR. ELIOT'S FIVE-FOOT SHELF OF BOOKS

(*The Harvard Classics*)

Carlyle once said, "If time is precious, no book that will not improve by repeated readings deserves to be read at all." Time nowadays is more precious than ever before. We cannot, like the young Edison, attack the countless shelves of public libraries. Probably none of us possesses the persistency and patience which guided his early reading. We must have only the really great literature, the books that make us think straight, talk clearly and increase both our power to succeed and our enjoyment of life.

The Harvard Classics answer these requirements to the last detail. Already they are read and cherished in thousands of cultured homes. They are constantly bringing keen enjoyment and deeper understanding into busy lives. "Reading," as Edison himself says, "will never take the place of doing, but it enables us to travel twice as far with half the effort."

The Five-Foot Shelf is not a "rich man's library." By the famous Collier plan these wonderful books are brought within easy reach of everyone. Do not put off finding out more about this invaluable set. Mail the coupon today!

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Before you spend another penny for books, get a copy of "Fifteen Minutes a Day"—the famous booklet that tells how to turn wasted minutes into growth and increased power. It's ready and waiting for you. Sending for it does not obligate you in any way.

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By mail, free, send me the booklet that tells all about the most famous library in the world, Dr. Eliot's Five-Foot Shelf of Books (The Harvard Classics). Also, please advise how I may secure the books by small monthly payments.

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Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

BOTH raw and boiled linseed oil should be kept on hand in every home workshop in stoppered bottles or cans. The raw oil dries very slowly, but the boiled oil acts as a drier. When dry, both give a tough and elastic membrane.

When boiled with certain metallic compounds known as driers, linseed oil is used in the manufacture of paints and varnishes, oilcloth and linoleum. Linseed oil is soluble in turpentine, carbon bisulphide, mineral oils, benzol and benzine.

It is, of course, known that ordinary putty consists of linseed oil and whiting, and that the groove to be puttied should first be painted with linseed oil. Pipe joints are usually painted with a mixture of linseed oil and red lead to insure gas-, air- and waterproof joints.

An auto top dressing may be made by first mixing a solution of benzol and asphaltum. When dissolved, this should have the consistency of milk. To each pint about two or three tablespoons of linseed oil are added to make the dressing more flexible.

How paper treated with a gluelike birdlime is bound to a tree with wire to catch caterpillars and stop them from going to other trees

A birdlime that catches caterpillars and prevents them from traveling from tree to tree is made by melting one part of lard in from three to five parts of linseed oil in which one part of rosin has previously been melted. This mixture is brushed as a ring around the trunk of the tree, where it remains, gluelike, for a few weeks. It may also be spread on paper and applied as shown in the illustration.

Although linseed oil does not dissolve—at least not to any appreciable extent—in alcohol, it can be made alcohol soluble by treatment. The harder rosins, which are used for the better varnishes, dissolve in linseed oil with difficulty; but when the oil has been treated to make it alcohol soluble, they dissolve readily.

First the linseed oil is saponified with potassium hydroxide, which gives a soft soap, or sodium hydroxide (lye), which gives a hard soap. The caustic is dissolved in water and mixed with the linseed oil. Place the mixture on a water bath or under a small heater and stir until it is thick; then add hydrochloric acid slowly until sufficient acid has been added to break up the soap. The linseed oil acids are set free and float on top of the acid liquid. The treated oil is then decanted from the aqueous solution below, washed with water and, after settling, is again decanted. It will now dissolve the harder rosins, such as the copals.

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Underwear that *Overwears*

is an economy!

Measured by *length of satisfactory service*, "B.V.D." is the least expensive underwear. Measured by *fit* and *comfort*, nothing else *compares* with it!

Specially woven and treated nainsook—lock-stitched seams—buttons sewed on to stay—many special reinforcements—give "B.V.D." definitely longer wear.

Exclusive features—such as the patented closed crotch, and encircling waist-web of "B.V.D." union suits—highly specialized *methods* of cut, tailoring and finish—give "B.V.D." inimitable fit, coolness, and ease.

Years of unchallenged world-leadership attest "B.V.D." quality.

Insist on this red woven label.

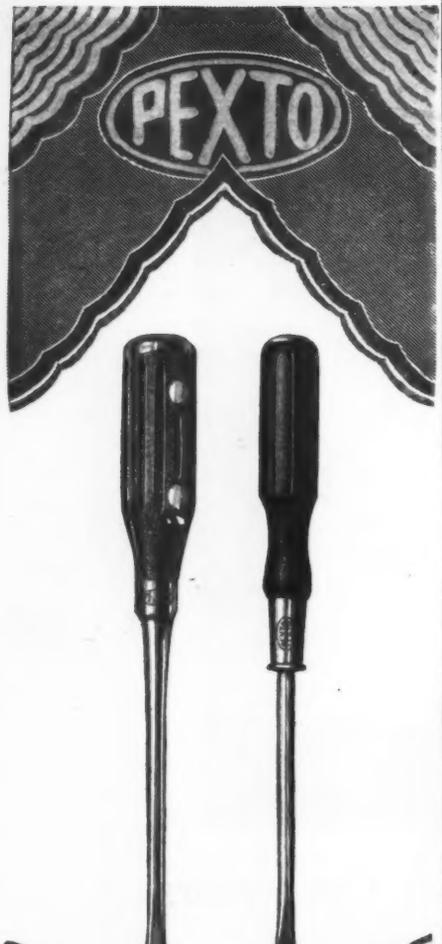
MADE FOR THE B.V.D. BEST RETAIL TRADE

Trade Mark Reg. U.S. Pat. Off. and Foreign Countries

Men's Union Suit $1.50 Shirts and Drawers the garment 85c
Youths' Union Suit 85c
Shirts, Drawers, Shorts, Men's and Youths' Union Suits obtainable in fancy materials at various prices.
Children's Reinforced Taped Waist Suits 75c the suit.

The B.V.D. Company, Inc., N.Y.
Sole Makers "B.V.D." Underwear

"Next to Myself I Like 'B.V.D.' Best!"



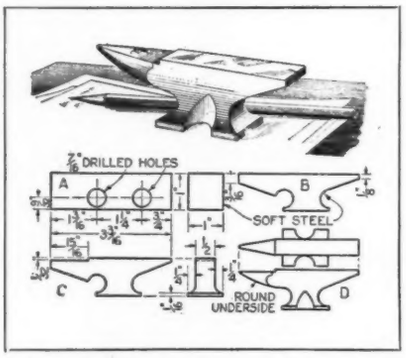
There's many a call for a good sturdy Screw Driver. The PEXTO line includes all types—the No. 3 with a solid forged steel bar and the No. 12 Carpenters' style illustrated above are two of the most popular.

Ask your dealer to show you some PEXTO Tools and write us for booklet on the complete line.

PECK STOW & WILCOX CO
SOUTHINGTON, CONN. U. S. A.

Anvil Makes Novel Paper Weight

AN ATTRACTIVE little paper weight to take home is this month's project for the school machine shop. It is a valuable exercise for young machinists because it affords an opportunity to obtain useful experience in filing flat



Four steps in shaping a miniature anvil to be used as an ornamental paper weight

surfaces, and operations similar to those often required in punch and die work.

Cut off a piece of soft steel 1 by 1 by 3 3/16 in., lay it out and drill it as at *A*, and mill it to shape as at *B* or cut it out with a hack saw. Then mill or saw it as at *C* and finally finish it with a file as at *D*. Polish it carefully.

This is the fourth of a series of designs for boys or young men who are studying shop practice.—H. B. KELLAM.

Kinks to Aid Machinists

(*Continued from page 86*)

A SIMPLE milling attachment for use on an engine lathe is illustrated in Fig. 6. The work is mounted on the lathe spindle and rotated by the left hand, the back gears being in mesh, while the right hand controls the cross slide, which supports the milling fixture. The milling spindle should be well made, preferably with tapered bronze boxes supported in either a steel or cast-iron quill. The quill is housed in any suitable support, such as an angle iron as shown, which may be secured to the tool post support or the cross slide. The cutter is driven from the regular countershaft.—O. S. M.

WHEN it is necessary to drill oil holes from different planes so that one hole passes squarely into the wall of another hole, the simple fixture illustrated in Fig. 7 saves much time. Hole *A* is first laid out, center-punched and drilled to the required depth. The pin on the fixture is then inserted in hole *A* and the fixture used as a drill jig for hole *B*. Despite any small misalignment in the drilling of hole *A*, the holes will connect with each other.

If any great number of holes are to be drilled, a hardened steel bushing should be added to the fixture for hole *B*. The fixture could be designed, if desired, to allow for making a wide range of adjustments.—HAROLD N. WHITMORE.

Worn Roofs
made watertight

IT'S easy now to keep your roofs watertight. Rutland No-Tar-In Roof Coating makes an old roof as good as new. No trouble at all to apply—costs little—and makes a *lasting* job.

Rutland No-Tar-In provides a perfect coat of asphalt and asbestos—*a tough mineral covering*. Not a drop of tar in it. It will not crawl, sag, harden, peel or blister. For every kind of roof (except shingles).

Insist on Rutland at your hardware or paint store. Save money by mailing the coupon today. Rutland Fire Clay Co., Dept. R-20, Rutland, Vermont. *Also makers of Rutland Patching Plaster.*

Rutland
No-Tar-In ROOF COATING

RUTLAND FIRE CLAY CO.,
Dept R-20, Rutland, Vermont.

Send me more information about No-Tar-In.

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See Miles Away! with Big 3½ Ft. Telescope

5 DAY TRIAL

5 Sections 8-Power

Brings distant people and objects close to your eyes. Wonder telescope opens over 3½ ft. long, 5 big sections, brass bound, 8-power lenses. Ideal for sports, camping, travel.

Read numbers on freight car miles away.—A. C. Palmer.

FREE CARRYING CASE AND SHOULDER STRAP

SEND NO MONEY

On arrival pay postman $1.85, plus postage (if for $3.50). Or send $1.85 and we pay postage. Try 5 days. Money refunded if not delighted. Send today.

FERRY & CO., DEPT. 1789 CHICAGO, U. S. A.

HB PAINT SPRAY "DOES THE WORK OF FIVE MEN"

QUICK, EASY PROFITS! Practically no investment. Small space required. Steady demand and BIG PROFITS refinishing autos, furniture—painting houses and barns with HB quick spray method. One man does the work of five with brushes. Pays for itself on easy monthly payments. 30 DAYS' TRIAL. Write today for details.

EASY TERMS 30 DAYS TRIAL QUICKLY PAYS FOR ITSELF

HOBART BROS. CO. Box P581, Troy, Ohio

Making the Most of a Lathe

(Continued from page 84)

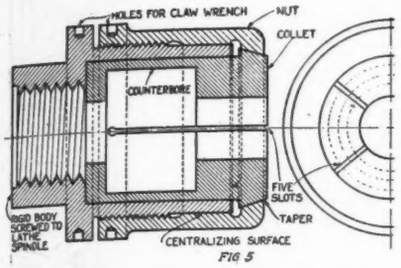


FIG 5

Spring chuck which has eighteen collets and takes stock from 1/8 to 3 in. in diameter

fastened, slides into the T-slot on the compound rest. Besides the large bar shown, there are two smaller ones, provided with compensating sleeves. The sleeves are slotted on one side and the central portion of their length is turned thin to give the necessary spring.

It will be noted that the bar is provided with squared holes at both ends to take the tool bits. At one end the hole is at right angles to the center line of the bar and at the other there are two holes on the same plane and crossing each other at right angles. The latter are set at 45 degrees to the center line.

AFTER this boring bar and holder are set in the required position, the nut clamps the bar firmly and fastens the whole device solidly on the compound rest, all in one operation. The feature of being able to adjust the bar in a horizontal direction independently of the position of the compound rest, as well as the various ways in which the bits can be held, has greatly increased the range of this boring tool. I have used it for both internal and external work, in the latter case where the diameter of the work was unusually large for the machine. Turning, boring, thread cutting and facing are done with equal ease with this tool.

Hollow mills of the type shown in Fig. 2 are used in the six-tool turret center. There is also another hollow mill holder with a shank to fit the tapered hole in the tail center; this is used for larger work and for the making of pins, studs and shoulder bolts where the use of the turret can be dispensed with.

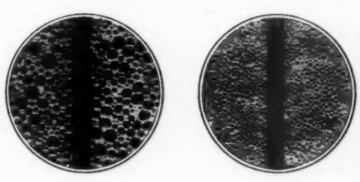
The hollow body of the holder is bored to take the mill, which is held in place with an inserted key. Diametrically opposed to the key and keyway is a set screw of the headless kind, which passes through the holder and presses against a slanting flat on the hollow mill. This flat slopes towards the center of the mill and in the direction of the point or cutting edges; the set screw therefore tends to cause the mill to remain in the holder, pressing hard up against the shoulder.

In the making of small shoulder bolts, a hollow mill and the four-way tool post make possible fast production.

There are times in our shop when hundreds of shoulder bolts have to be machined out of 1¼-in. round bar stock. The bar is placed through the hollow spindle of the lathe (Continued on page 106)

We Offer Men

a faster, smoother shave this new Small-Bubble Way

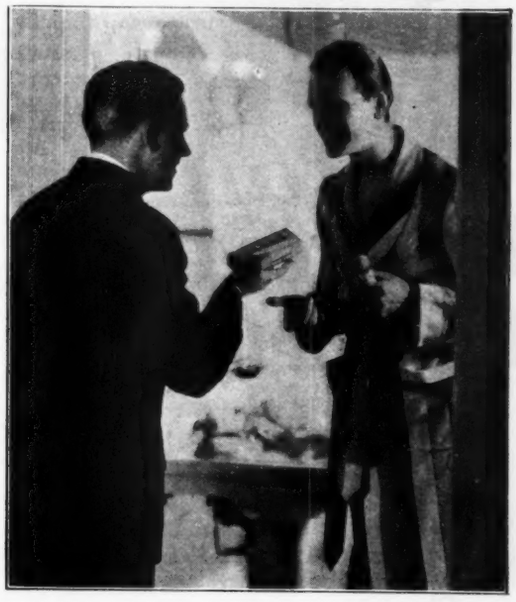


Ordinary Lather

Photomicrograph of ordinary lather surrounding single hair. Note how the large bubbles hold air instead of water against the beard.

Colgate Lather

Under identical conditions note the closely knit texture of Colgate lather. The small bubbles hold water instead of air against your beard.



"There's really no mystery to it, sir! This 'small-bubble' shave cream certainly makes it easy for your razor."

BEARD stubborn . . . skin tender? Forget it, men! Here's a quick new way to get whiskers off clean and smooth, without razor-pull, sting or smart. See unique offer in coupon below.

Can you imagine a shave that leaves your face smooth as velvet? A shave that keeps your skin fresh and invigorated . . . delightfully clean and cool? A shave that stops razor-pull, drag and scrape?

It's a shave with a smile . . . glorious comfort from start to finish.

Small Bubbles . . . that's the theory of it. A brand-new principle of shaving that soaks whiskers soft in a hurry.

Already millions have adopted it. Thousands now buy it daily.

But we want you to try it, too.

So we're offering a test that any man can make with unique results. See coupon below.

Small bubbles did it

No other shaving cream is like Colgate's.

It is, we believe, the ultimate attainment in the science of beard-softening. A shaving cream based on the now proven principle that water, and not soap, is the real softener of your beard.

Thus Colgate lather is designed to absorb more water . . . to scientifically drench your beard with moisture right at the base, where the razor work is done.

It's a "small-bubble" lather. For small bubbles hold more water. They carry it closer to the base of your beard.

You'll say, "Good-by, Razor-Pull"

The minute you lather up with Colgate's, two things happen:

1. The soap in the lather breaks up the oil film that covers each hair . . . floats it quickly away.

2. Then billions of tiny, moisture-laden bubbles seep down through your beard . . . crowd around each whisker . . . soak it soft with water.

Instantly your beard gets moist and pliable . . . softened right down at the base.

Thus your whiskers come off clean and smooth.

No razor-pull. No stinging and smarting. Twice-over shaves aren't needed now. Your face feels clean, fresh, smooth, invigorated.

Clip that coupon before you forget.

We will also send a trial bottle of Colgate's "After Shave." It's a new lotion which is making friends every day.

Just jot your name and address on the coupon . . . and leave the rest to us.

SEVEN WONDERFUL SHAVES...FREE...If you're willing to judge Colgate's on its merits...we'll cheerfully pay for the test. Mail coupon.

FREE OFFER, *MEN!*

Colgate & Co., *Dept. 500-E*, 595 Fifth Ave., New York

Please send me FREE sample of Colgate's Rapid Shave Cream. Also sample of Colgate's After Shave.

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Address_____

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Champion—for all cars other than Model T Ford—75c

Champion X—for Ford Model T—60c

Install Improved CHAMPIONS now!

Check the mileage on your speedometer today—and if over 10,000 miles, be sure to put in new Champions.

Even if your car already has Champions and seems to be running smoothly, you will find it pays to make the change.

New spark plugs are not an expense because they quickly save their cost in less gas and oil used—*plus* greater motoring satisfaction.

Be sure and install Champions—for only Champion will give you the exclusive sillimanite core—the new sillimanite glaze which keeps free from carbon and oily deposits—a new, patented compression-tight gasket seal and improved special-analysis electrodes.

Champions *are* better—that's why they outsell two to one.

CHAMPION *Spark Plugs*

TOLEDO O

Making the Most of a Lathe

(*Continued from page 105*)

and held in a spring chuck (Fig. 5). The body and end of the bolt are turned and milled to the required sizes; the die threads the bolt, thus saving the time of chasing, and it is cut off by a tool held in the four-way tool post.

In Fig. 3 is given a sectional view of the larger of two kinds of die holders used in the tailstock spindle. A special tailstock spindle receives the tang and helps resist to a certain extent the torsional stress while the thread is being cut.

IN OPERATION the ways of the lathe are kept well oiled and free from grit. The tailstock slides along the ways in the same manner as the carriage on a bolt cutter. The lathe is allowed to run at a speed to suit the size of the bolt or thread being cut. Reversing the lathe backs the die off.

A smaller die holder takes dies for machine screws. Many of special types are used in the electrical and electropneumatic devices on subway cars. One particular case calls for the making of hundreds of 10-32 studs 3¼ in. long and threaded their full length.

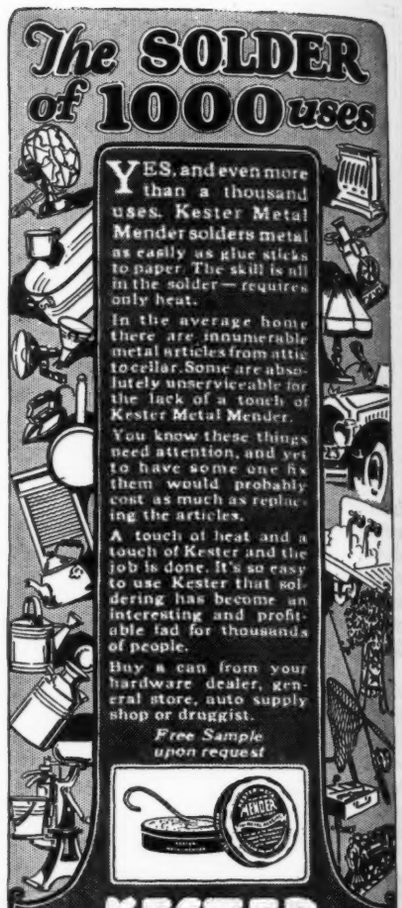
The screw that operates the spindle and the piece that holds this screw in place on the tailstock are removed. The spindle is clamped in the tailstock and the small die holder is placed in the tapered hole that ordinarily takes the center. There is a clear hole through this die holder, in which respect it differs from the one shown in Fig. 3.

The brass rods used to make these studs are 36 in. in length. One is held in the drawing-in attachment with about 8 in. of its length extending to be threaded by the die. The lathe runs at from 120 to 150 r.p.m. As soon as the die catches, it feeds itself on to the rod until the exposed portion is cut. More of the rod is exposed from time to time. The threaded part passes into the hole in the tailstock spindle. This is continued until only a ⅛-in. length of unthreaded rod is held in the attachment. That is cut off with a hack saw and the finished rod removed from the die with a few turns. The threaded rod is then cut into the required lengths.

In the threading of larger rods, such as for 14-20 studs or up to ⅜ in., as much as 18 in. is threaded at a time.

THE six-tool turret center illustrated on page 84 carries hollow-mill holders, die holders, drill chuck and a center, and it has a place for drills. The turret is set at 45 degrees to the lathe center, so that the tool not in immediate use swings away from the work in the chuck. A pawl and thumb-screw holds each tool in position.

The four-way tool post is considered an improvement on similar devices that are being marketed. A pawl and nut hold the revolving turret in exact position. The pin on which the turret turns is threaded at the top to take the clamping nut and is fixed to the part that rests on the compound rest. The body of the pin is hollow, and through this (*Continued on page 107*)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Making the Most of a Lathe

(Continued from page 106)

hole a stud with a squared head passes down to the clamping piece that slides into the T-slot of the compound rest. Thus the tool is held firmly, yet the turret can be turned when the clamping nut is slackened. By this means each tool can be gaged by the graduations on the cross-feed screw.

Another product of the shop is the spring collet chuck shown in Fig. 5. It is a little different in construction from the kinds generally used and has a capacity for round stock from ⅞ in. up to 3 in. in diameter, increasing by eighths.

THE chuck has a rigid body, one end provided with internal threads to fit the spindle of the lathe and the other end bored to take the collets. The flange of the body has holes to take the pin of a claw wrench, as has also the clamping nut.

The front part of the outside of the body is turned smooth and parallel and in the interior of the clamping nut a corresponding area is bored to fit this surface, which forms a centralizing area and keeps the device constantly true.

The tapered bore in the end of the nut, which fits over the end of the collet, is slightly arched to insure perfect smoothness in the working of these parts. The collets are bored to the required sizes, then counterbored to give the required spring, and slotted in the milling machine. In doing the slotting, a dividing head is used so as to insure uniformity in the spring of each segment.

The only reason why the smallest size collet of this chuck is ⅞ in. is because the lathe also has a drawing-in attachment that takes sizes increasing by sixteenths up to ¾ in.

One other idea for using the lathe, which seems not to be generally known, is illustrated in Fig. 4, page 84. The joints in the brake rigging used on the trucks of subway cars are lined with pack hardened bushings, which are made from solid drawn steel tubing, cut to the required lengths, hardened and pressed into place. The tubings are bought in lengths of the required inside and outside sizes; all that is necessary is to cut them up. As the tubings are of a diameter too large to pass through the hole in the spindle of the lathe, a 6-ft. length of the tubing, which is all the lathe will take, is held in the dog chuck or the spring collet chuck. The spring collet chuck is preferred because it is more accurate and far more rigid than the dog chuck.

The follower rest is fastened to the carriage of the lathe and set up to the tubing. A cutting-off tool is held in the tool post in such a manner as to cut about ⅛ in. behind the place on the tubing where the dogs of the follower rest bear. The first bushing is cut with the finest automatic cross feed and when it falls another bushing is measured off and the cut started again. This is continued without stopping the lathe.

The same set-up is often used in cutting dowel pins from bar stock and other work of that nature.

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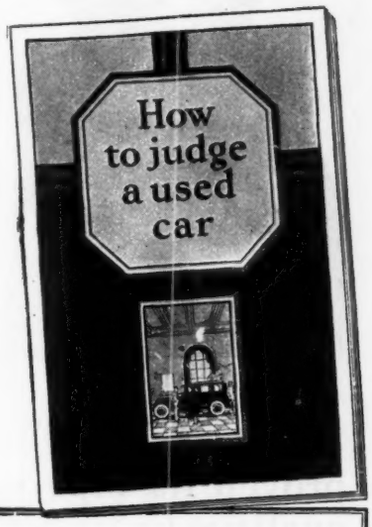

THE fund of facts in "How to Judge a Used Car" may easily save you $200 or more in buying a used car! Boiled down into ten minutes' interesting reading are the safeguards experienced *automobile dealers* apply when *buying* used cars for resale. Every paragraph is the summary of years of experience—every page is full of time-saving, money making pointers.

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STAR HACK SAWS

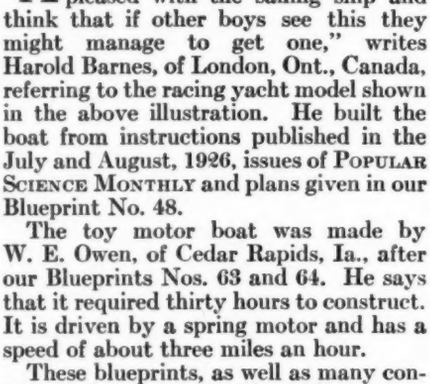
Models Made from Our Blueprints

Harold Barnes, of London, Ont., with a yacht made from POPULAR SCIENCE MONTHLY plans

"AS YOU will notice, I am more than pleased with the sailing ship and think that if other boys see this they might manage to get one," writes Harold Barnes, of London, Ont., Canada, referring to the racing yacht model shown in the above illustration. He built the boat from instructions published in the July and August, 1926, issues of POPULAR SCIENCE MONTHLY and plans given in our Blueprint No. 48.

The toy motor boat was made by W. E. Owen, of Cedar Rapids, Ia., after our Blueprints Nos. 63 and 64. He says that it required thirty hours to construct. It is driven by a spring motor and has a speed of about three miles an hour.

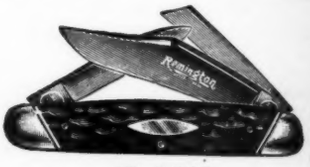
These blueprints, as well as many containing designs for models of historic vessels, can be obtained from our Blueprint Service Department for twenty-five cents each. See the list on page 101.



A toy boat built by W. E. Owen, of Cedar Rapids, Ia., after Blueprints Nos. 63 and 64

WHEN pressing men's ties, cut a tapering piece of cardboard and slip into the tie, small end first. This will hold both lining and material taut and prevent wrinkling. After pressing one end of the tie, insert the cardboard form in the other end and press that. The cardboard around which laundried shirts are folded serves well for making the forms.—C. H. NOYES.

Knives That Bite



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The blades in this knife are super-sharp—hand-honed at the factory.

They are made of the best high-carbon blade steel obtainable, uniformly hardened and tempered to the proper degree. The edge that bites will last.

This knife is light in weight. You can carry it in your pocket without knowing it's there, but it is sturdy—built for hard, practical use by carpenters, skilled mechanics and amateur craftsmen.

Has a good-size, heavy-gauge clip blade, a pen blade and a cut-off pen blade for scribing, cutting builders' paper, canvas or other heavy material. Shinbone stag handle with spun rivets—no cracked handles due to hammered rivets. Nickel silver bolsters and shield. Brass linings. Beautiful finish throughout.

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THOMPSON BROS. BOAT MFG. CO.

Refinishing a Canoe

(Continued from page 90)

best, as you are less likely to produce runs on the uneven surface when applying the varnish sparingly.

Now turn the canoe bottom up. If the paint is not too thick and is not cracked, you may sand it down to a clean, fine-toothed surface and refinish in the same color with one coat of good canoe enamel or ready mixed color and marine varnish, or in a different color with two coats. In either case the color coat or coats must be followed by a flowing coat of clear varnish. One word of warning is necessary: If you have been polishing your canoe with wax or oil, wash it off very thoroughly with hot water and washing soda before sandpapering the surface and applying enamel or varnish, neither of which will dry over the least trace of wax or oil.

If cracks show in the paint, or if your inquisitive knife blade unearths half a dozen different shades in scraping its way down to the buff-colored filler, it is time to peel off the old coats and give your canoe a new lease on life.

This may be done in various ways, one of the simplest of which is to use hot water and lye. Wear rubber gloves to do this, for the stuff will burn like fire and the sores will be a long time healing. The lye must promptly be washed off, too, for it will eat canvas as well as paint.

ANOTHER popular method requires the use of a gasoline blowtorch. The torch is held to the paint with one hand while a sharp putty knife, wielded in the other, peels off the burned paint. It is easy to burn the canvas and still easier to run your scraping hand into the rebounding flame of the torch.

In every case when the old coat has been removed by the lye or torch process, it will be necessary to fill the weave of the canvas. This may require several coats. While a filler of white lead and oil is often used, I prefer, because of their greater elasticity, the special fillers manufactured by the canoe companies.

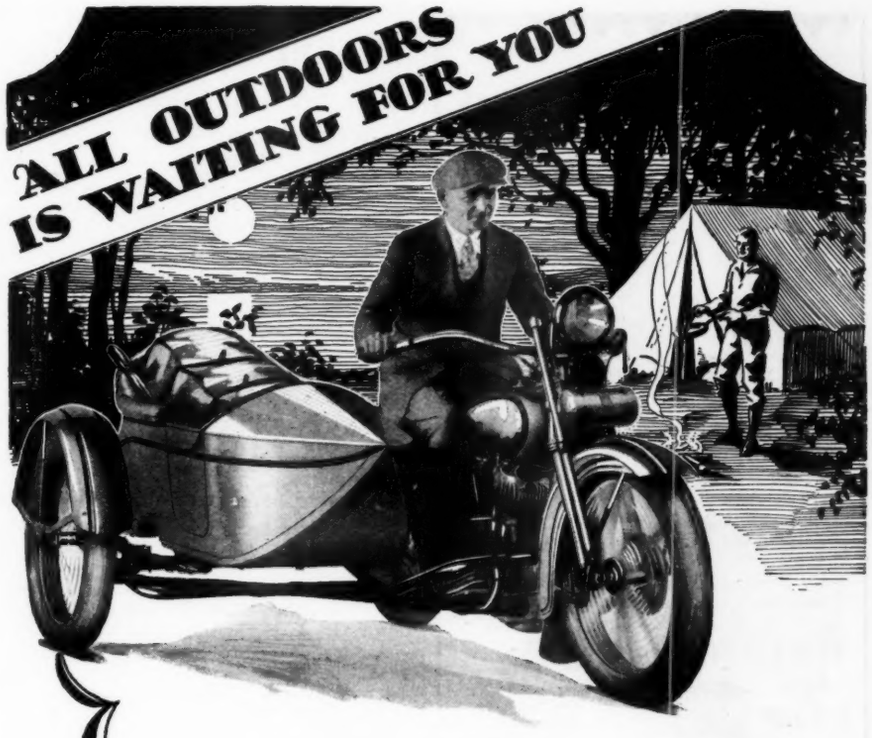
The old reliable sandpaper and elbow grease serve very well if there are not too many coats to be removed; but if one of the glass-hard floor varnishes or enamels has been used, you will be obliged to resort to one of the more drastic methods. If you elect to use sandpaper, throw it away as fast as it becomes clogged. Don't use a block to wrap the paper on, for your hand fits the rounds and hollows of the hull and the block does not. Before painting, rub the surface smooth with fine paper.

If, after the old paint has been removed, the weave of the canvas shows even slightly, a coat of filler, thoroughly rubbed smooth, is desirable as a groundwork for your color coat. For the latter select a first-class coach paint, ground in japan, and mix it with pure turpentine. Apply it with a coach-painter's soft-bristled color brush. One color coat is usually sufficient, but if the first looks uneven a second will do no particular harm. Have the paint thin enough to spread without brush marks and allow at least twenty-four hours to dry before varnishing.

To the first coat of varnish should be added about twenty percent pure turpentine. After it has thoroughly dried, it should be carefully rubbed with the finest sandpaper. The second coat of unmixed varnish is applied, rubbed smooth and followed by a third, which is the final or flowing coat. For this coat, which gives the desired depth and luster, pick a dry, warm day with sunshine and a bit of breeze, for varnish is sensitive, and the weather materially influences its action.

Wales and decks come last, as the canoe rests on the wales while most of the other work is being done.

Large dents may be filled with a plastic wood filler, or the damaged places may be cut out and inlays substituted; (Continued on page 110)



ISN'T there a restless, "want-to-go" feeling in your blood these days? Remember that last vicious "strike" when the biggest one got away? He's still there — a year bigger, a year *hungrier* — and waiting for you!

Go there after him on a Harley-Davidson Twin. Crowd your vacation days and week-end trips with added hours of healthy, thrilling sport. Over any highway or trail this famous mount will carry you swiftly, safely and comfortably. Lots of room in the sidecar for a pal and your outfit!

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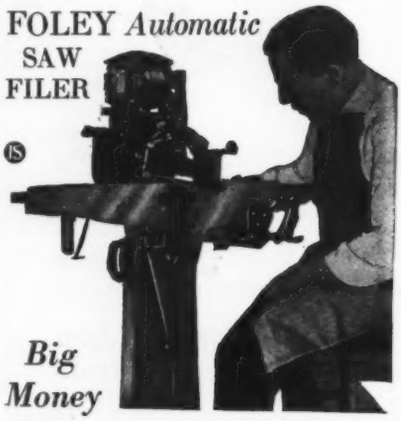

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Name_____

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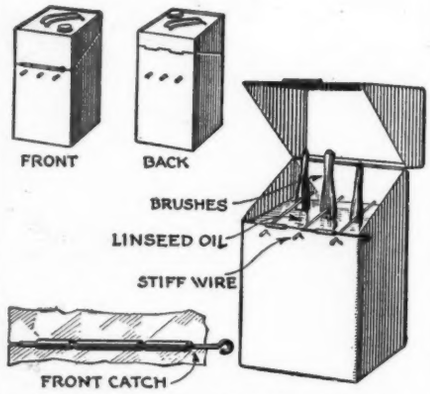
Refinishing a Canoe

(*Continued from page 109*)



A container for brushes easily made from an automobile oil can or a large syrup can

small dents may be scraped smooth, treated to two or three coats of varnish and rubbed down with extra thoroughness.

A word in regard to color: Many colors wear poorly, particularly dark and flashy colors, which look cheap the moment they receive a little hard usage. Tints—grays, blues, greens, tans, browns—hardly show scratches at all and are easily kept clean. A new varnish coat or even a thorough polishing will make them look like new, provided the color coat has not been materially damaged.

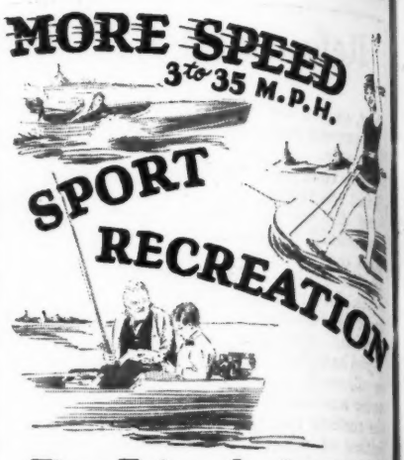
If the varnish is at body temperature when applied, it will flow out and dry better. Your containers of paint and varnish should be scrupulously clean, and you should move about the job slowly to avoid stirring up a dust.

A SUGGESTION for making brush containers and varnish cups is given in the illustration above. There are also two diagrams on page 90 to illustrate how varnish is applied. It is first brushed on quickly and freely with back-and-forth strokes, covering a convenient area, say one foot square. The surplus varnish is then removed from the brush by scraping it on the edge of the varnish cup or over a wire inserted through the top of the cup for this purpose. The surface just covered is next "laid off" with light strokes made in one direction only and at right angles to the strokes of the first operation. The dotted lines in each diagram show where the strokes lap over the area already varnished. Start at one end of the canoe and, of course, do only one side of the canoe at a time.

You should buy and use the best brushes, which you can wash out with turpentine, soap and hot water and lay away for future use. And don't let some wiseacre buy your canoe at half price after you have denuded it of its excess paint, for you then have the job three fourths over, and the last quarter is by all odds the most enjoyable.

BRILLIANTLY colored marbled paper, which has many uses in craft work such as for making lamp shades, covering fancy boxes and decorating novelty furniture, can be prepared easily and at little expense. Obtain artists' oil colors, which come in tubes, and dilute a small amount of each with turpentine. Fill a tray with water in which a small amount of gum tragacanth has been dissolved—just enough to make the water slightly gelatinous. Then stipple or throw the paint with a stiff brush on the water and blow the surface or rock the tray to cause the colors to flow together and make an interesting pattern.

To transfer the film to paper, it is necessary to place the sheet carefully on the water, lift it off, then rinse it thoroughly to wash off any excessive amount of paint.



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Fleetwin — a new motor, full 6 H. P. only 35 lbs. 11 to 25 m. p. h. on hydroplane, 10 to 18 m. p. h. on square stern canoes, 9 to 16 m. p. h. on modern design rowboats.

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Beautiful Evinrude Year Book, free. Down payments as low as $30.

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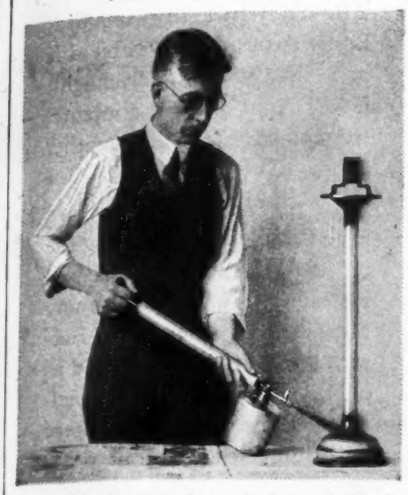
Hand Sprayers

(Continued from page 77)



Decorating the base of a smoker's stand. Hand sprayers are especially useful for finishing wicker, reed and fiber furniture, radiators, furniture novelties, and objects with carvings

gallon of alcohol—can be applied with the spray gun if it is diluted at least twenty-five percent with denatured alcohol. Do not be afraid to thin shellac. A mixture of equal parts of commercial shellac and denatured alcohol makes a good sealing coat; indeed, it is often more satisfactory than a thicker coat.

In refinishing previously finished objects, it is only necessary to make sure the surface is free from grease, oil, wax, dirt and moisture. Then sandpaper to cut the gloss and spray on the lacquer coats. In case, however, the piece was previously finished with mahogany stain, it is well to coat the surface with pure shellac to help seal in the stain and keep it from bleeding through and discoloring the lacquer finish. Some types of mahogany stain are almost impossible to cover so thoroughly they will not come through in time.

"NOW can't we try to lacquer something?" Mrs. Andrews interrupted eagerly.

"By all means. What shall it be?"

"Let's start with this old smoker's stand," she said.

I showed her first how to grasp the gun with her left hand as close to the working head as possible to enable her to hold it steadily.

"Keep the nozzle eight or ten inches from your work," I said. "Begin pumping and make the strokes in line with the hand holding the sprayer; this will reduce wobbling and tend toward an even coating of lacquer over the entire surface. Always spray the long way of the surface, which is almost invariably with the grain, and always work into corners, not out from them. In doing large panels like a chair seat or a table top, start in the center and work out. Spray edges, moldings and corners last."

Mrs. Andrews was making hard work of it, but she quickly learned to take long, easy, firm strokes, pulling back quickly and going forward slowly, with just enough pressure to keep the lacquer flowing through the nozzle.

Next we refinished a wicker basket. Reed, fiber or wicker is sprayed lengthwise with the strands one way and then across the other way. This is the only way to get the lacquer or enamel well into the joints of the wicker.

"As soon as you are through," I went on, "the sprayer should be cleaned—immediately. If there is any lacquer left, pour it into a container and seal it up. Be sure to mark it, so you will remember it has thinner added. Then rinse out the tank with a little thinner, and also squirt some of the thinner through the working head

(Continued on page 112)

Files That Save Time

Files have a lot to do with the Average Golfer's Score

Bill Creavy, pro at the Bonnie Briar Golf Club, Larchmont, N. Y., says:

"The average golfer may not know it but files have a lot to do with the average golfer's score. The file is responsible for the bevel on the head of the driver, brassie and spoon. Every golfer has his own particular stroke. They all want different angles on their wooden clubs. It is for this reason that we use nothing but Nicholson Files. Their teeth bite into the hard wood and get just the right angle on the head of the club that each individual golfer desires."

You can do hundreds of jobs faster with NICHOLSON Files. Their capacity for working at high speed accounts for their popularity in industry as well as the home.

Booklet "Files and What They Will Do For You" sent without obligation.

NICHOLSON FILE CO.
25 Acorn Street
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NICHOLSON U.S.A. (TRADE MARK) —A *File for Every Purpose*

SKILL—it's easy when you have good tools!

TO approach the finished work of a skilled mechanic, one should acquire and use the same high-grade tools. Here, for instance, is the newest thing in clamps—the *clamp with multiple disc clutch and four wheel brakes*, the "wheel base" being as long as any piece of ¾" pipe you want to use.

"PONY" CLAMP FIXTURE

A few odd lengths of pipe and these fixtures are all you need to make a whole series of clamps.

Malleable iron castings, enameled, with steel screws, Acme type threads, per set (without pipe). . . . **$1.80**

(Postage extra, mailing weight per set 3 lbs.)

DOWELING JIG

Here's another tool that promotes skill—a doweling jig that enables you to drill holes anywhere you want them—end, side, or edge of your stock—with amazing speed and accuracy. Makes the most complicated doweling job a joy to accomplish. Fully described in our catalog 615-P. Complete as shown with five guides, **$2.60** postpaid.

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A text book of 196 pages on the use of woodworking tools, written in non-technical, simple language all may understand. Contains clear and detailed directions for making many household conveniences such as porch swings, trellises, window screens, etc., and for doing all kinds of repair work. Profusely illustrated with diagrams. . . . Postpaid **$1.65**

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Kindly send me your FREE catalog No. 615-P —all about Tools for the Home Workshop.

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Hand Sprayers

(Continued from page 111)

and nozzle by stroking the pump a few times with the top of the tank fastened on."

"Easier than cleaning out brushes," commented Mrs. Andrews.

"No harder, anyway," I agreed, as we turned our attention to refinishing the top of a small table. "And besides this plain work, there are, of course, some 'fancy' things anyone can do with a spray. For instance, there's shading. It's not nearly so difficult as it looks. You simply hold the gun at a forty-five-degree angle, about four or five inches from your work, and move the spray more rapidly over the surface than in doing solid covering. It is better to apply the desired density of shade by moving the gun rapidly back and forth over the surface several times than to try to get it all in one operation.

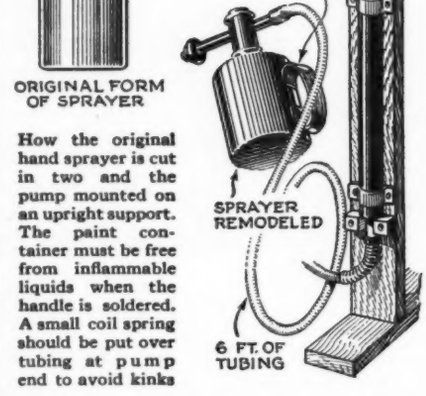
"Then there's stenciling. Some amateurs have done attractive work by spraying lacquer colors through a stencil. You have to be careful, though, for if the color runs over the edge of the stencil it can't be wiped off as easily as an oil color. Nevertheless, the sprayer offers about the only way you can stencil with lacquer. If you try to pounce it on with a brush, you are likely to soften and pick up the under color. Personally, I prefer to use oil colors for stenciling rather than lacquer, whether applying with a spray or brush.

"One more point: Besides this type of sprayer, you can now obtain another and slightly more expensive design in which the pump and the spray gun are two separate units, with a rubber tube connecting them. You work the pump with your left hand, as if it were a tire pump, and guide the spray with your right hand. The pumping motion then does not interfere in the least with the accurate control of the spray."

"Guess I'll be trying all this 'fancy' work before long," put in Mrs. Andrews. "I'm going to get a hand sprayer right away and see first what I can do in the way of painting some of the new and very attractive pieces of unfinished furniture the department stores are featuring."

Improving a Paint Sprayer

HAVING experienced trouble in the use of a hand spray gun because the pumping motion throws the guiding hand off the work, I rigged up the device illustrated below. It is a great timesaver and does better work than a brush. I have used it in refinishing several bedroom sets and in lacquering an unfinished breakfast set. The frame is of pine 1 by 3 by 28 in., as I am rather tall; the foot is 12 in. long.—GEORGE V. BAKER.



How the original hand sprayer is cut in two and the pump mounted on an upright support. The paint container must be free from inflammable liquids when the handle is soldered. A small coil spring should be put over tubing at pump end to avoid kinks

Signed off

THAT's what my set did. Loose ground-wire. Found it in a jiffy with my flashlight. Everything okeh in a minute. Might have missed another good "Eveready Hour" if I hadn't had that flashlight.

A flashlight is certainly the handiest household implement we own. I wouldn't use any but genuine Eveready Batteries in ours—same brand as on my "B" circuit. Dependable—they are always *there* with light when you need it.

Get the flashlight habit—it's one you won't want to break. And always use Eveready Batteries.

Better than a Brush

for those 38 home uses already found for brushing Duco and other brushing lacquers. Quicker, easier, no muss or fuss. Smoother, richer finishes.

But That's Not All
Lacquer-Well Sprayer has 8 other uses: oiling car springs, whitewashing, regilding radiators, disinfecting, spraying gardens, etc. Automatic continuous spray action. Equal in material and results to any outfit within three times its price.

$4.50

***Lacquer-Well SPRAYER**

$2.50

We Pay Postage
Master outfit (at top), $4.50. Same, less tire pump, $2.75. Hand outfit (at left), $2.50. Extra tools with screw tops for keeping various colors or liquids, 25c each. Send check or money order. We pay postage anywhere in U. S. or Canada. Literature free on request.

The Lacquer-Well Spray Co.
2018 E. 105th Street Cleveland, Ohio

Model Ship Builders

Construction Sets And All Sorts of Separate Parts for the MAYFLOWER

Think of the pleasure of being able to work right along on your model without any worrying about suitable material for every part. Our valuable Mayflower construction set contains all the fittings of the proper thickness cut close to shape as well as all material for deck fittings, masts, yards, sails, cloth, finest rigging lines, etc. Everything to proper specifications. You can save time and money by purchasing one of these sets. Our large illustrated catalog describing this set and showing reproduction of photos of various other models together with prices on rough hulls, blocks, dead eyes, guns, anchors, capstans, etc., sent postpaid upon receipt of 10 cents (coin preferred). We can also supply construction sets for other Popular Science models and the world's most famous clipper ship, the Beautiful Flying Cloud. Be sure and send for our catalog before starting your model.

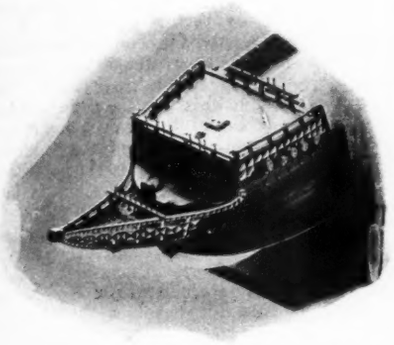
MODEL SHIP SUPPLY CO. DEPT. A MINEOLA, N. Y.

A definite program for getting ahead financially will be found on page four of this issue.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

The *Mayflower*

(Continued from page 92)



Looking down on the bow—a view to show the shape and decorations of headrails and trail boards

the anchor cables (see our Blueprint No. 85).

On the outside of the bulwark, between the first and second gun ports, there will be chess-trees. These are $\frac{3}{16}$ by $\frac{5}{16}$ in., of hardwood, fitted into the wales above and below, with $\frac{1}{8}$-in. holes through them and similar holes through the bulwarks just forward of them, as leads for the main tacks.

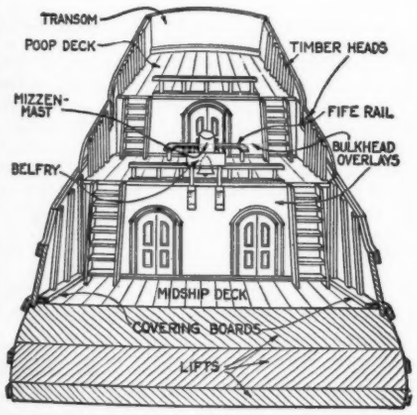
Lines may be scribed on the hull to indicate the joints between the planks, but these must be done carefully or omitted. A flexible strip of wood makes the best straightedge, and a blunt scriber, such as the corner of a putty knife, will indent the wood without tearing. Space off evenly between the wales at about $\frac{1}{4}$-in. intervals.

If the lower part of the hull is to be painted, it need not be marked, but if it is to be natural wood color, then it also should have plank marks. To get them about right, divide the hull amidships and at the ends into an equal number of spaces and scribe in evenly flowing curves to these marks. This will make them fanwise—wider amidships than at the ends.

That about completes the outside. Let us do some work on deck, so that we can get the handrails up and do some coloring.

Right around the edge of the upper deck (waist) lay in a covering board (called waterways at the sides) $\frac{1}{16}$ thick and $\frac{1}{8}$ in. wide. Across both ends of the higher decks, and also at the sides, if you wish, lay similar pieces.

Inside the bulwarks of the upper deck there should be 20 timberheads to a side, but if we put in seven spaced as shown on the deck plan between the gun port and the forward bulkhead, with three abaft that, that will be sufficient. They are a full (Continued on page 114)



Cross section of the ship looking toward the stern. The forward posts of the little belfry are carried on brackets which project from the first bulkhead; the other two posts are on a line with the handrail supports

She can't *Tell* you all she *sees*..

—when it comes to half-clean faces!

SOME things she *has* mentioned... his curly hair, his clean white teeth, and how well he looks in evening clothes.

But she can't tell him that her sharp woman's eyes have discovered what his mirror didn't—the pore-dirt that hides in every face.

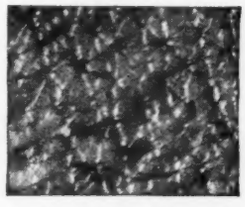
The air about you, according to the scientific study made by the U.S. Weather Bureau, is alive with millions of tiny specks of dust and soot. Too small to see, these particles float onto your face. Cling to the skin. Work into the pores. Get jammed *under* the skin.

Surface washing can't budge pore-dirt! These photos show that. And they show one other thing, too—that Pompeian Massage Cream rolls every gray speck free!

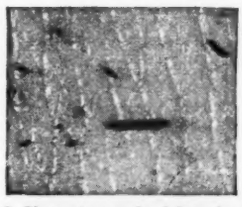
Rolls out pore-dirt that washing never reaches

Photo Number One, taken under the lens of a microscope, shows a section of skin before this pink cream was rubbed in. See for yourself the dirt in the pores.

Now look at picture Number Two. Some difference! Notice those dark marks—dried pellets of cream *gray* with pore-dirt that just a few minutes' massage rolled out.



1. Photomicrograph taken under lens of powerful microscope showing section of skin before using Pompeian Massage Cream.



2. Photomicrograph of skin after using Pompeian. Compare the skin tone. Note the dried pellets of cream, dark with pore-dirt that has been rolled free.

Remember, all the surface washings in a blue moon wouldn't have removed that dirt. But now—there's skin *really clean!*

Try Pompeian today. Give yourself a brisk two-minute massage.

Pompeian not only spruces you up with a gloriously clean feeling but sets you on your way with a complexion as glowing as a man just back from a long vacation.

Let this FREE test convince you

Pompeian is 60 cents at any toilet goods counter. You're welcome to test it FREE. Fill in the coupon below and mail it now.

POMPEIAN MASSAGE CREAM

The Pompeian Company, Dept. 901-E, 595 Fifth Ave., New York.
Canada: 72 St. Ambroise St., Montreal
Gentlemen: Please send me a free trial tube of Pompeian Massage Cream . . . enough for two cleansing, invigorating facial massages.

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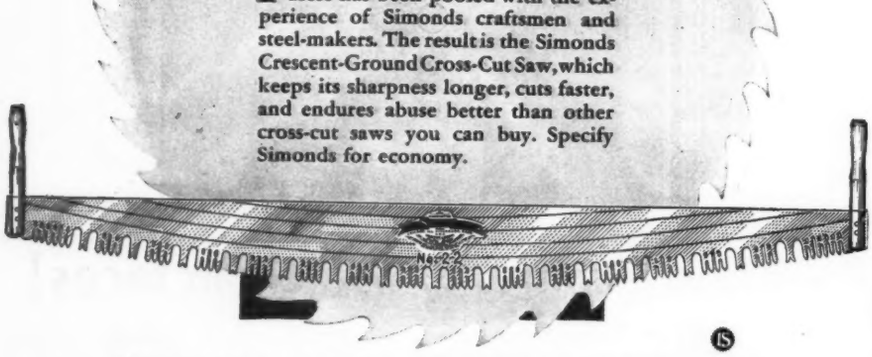
THE STANDARD SAW OF AMERICAN LUMBERMEN

THE experience of big woods saw-users has been pooled with the experience of Simonds craftsmen and steel-makers. The result is the Simonds Crescent-Ground Cross-Cut Saw, which keeps its sharpness longer, cuts faster, and endures abuse better than other cross-cut saws you can buy. Specify Simonds for economy.

SIMONDS SAW AND STEEL COMPANY

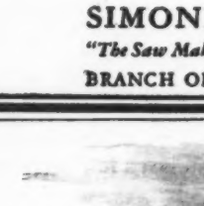
"The Saw Makers" Fitchburg, Mass. *Established 1832*

BRANCH OFFICES AND SERVICE SHOPS IN PRINCIPAL CITIES



The Red Arrow

—another newcomer



Stern view of Red Arrow showing one outboard motor mounted on transom, with demountable rear deck section removed.

Here's rocket speed in a dashing, swagger model as new and bright as the rainbow after a squall.

Sturdy framing, corrosion resisting Armco plates, lifeboat air chambers make the Red Arrow a true member of the Mullins family where safety and long life go hand in hand with beauty and speed.

Thanks to Mullins production methods, here is a speedster that just has *everything*—and just about hits bottom on price—way below what it looks like.

And thanks to the 1928 model *Duplex* hull, you can have your Red Arrow equipped with the Gray four-thirty, the bigger Universal Super-Four, or buy it without the motor for use with one or two outboards.

But, you want to know a lot more about it. Ask us to send you a copy of the new 1928 four color "Book of Boats." There you'll find all the dope.

Four Sea Hawk Models for 1928 in Armco Metal or Aluminum.

The side view gives a splendid impression of the clean racy lines and harmonious proportions of this vee-bottom speedster.

MULLINS

MANUFACTURING CORPORATION

301 DEPOT STREET - SALEM, OHIO

The *Mayflower*

(*Continued from page 113*)

$\frac{1}{16}$ in. square set into or onto the waterways and go to the top edge of the bulwarks. Cut them a shade long, then file them down level. They are all the better for being nailed through to the top wale, which we call here the waist rail.

Four a side will serve on the half deck. The butts of these and those on the poop and fore decks should be sunk into the deck and extend up to the height of the top of the handrails. There will be five on each side of the poop deck, and six, including the corner ones, on the forecastle.

When these are all firmly in position, take a strip of rattan (cane) spline or other flexible material about $\frac{1}{16}$ by $\frac{1}{8}$ in. and nail and glue it to the side of the sternboard and to each of the timberheads. Bend it sharply so that it will lie along the edge of the first dip, and butt it into the wale below. Repeat this for the half deck and forecastle rails.

THE outside is now ready for coloring. Below the load-water-line the hull may be painted an antique white or stained a natural dark wood color. I adopted the former plan, but afterwards felt that the dark stain might have been better. If it is to be painted, apply three or four coats of flat white well rubbed down between coats. Make the last coat thin and into it rub raw sienna, with here and there Vandyke brown and some dark green and with perhaps some so-called "light red" oil color wherever there might be rusty stains. The upper parts of the bulwarks and head rails will also need a couple of white priming coats.

For the natural wood parts use stains ranging from light oak, through rich browns, to nearly black, with touches of green, and perhaps some deep red along the wales. The channels should be black and the outsides of the gun ports, nearly so. The decks and insides of the bulwarks will be a light brown (weather-beaten light wood), with the timberheads a shade darker.

When colored, the whole should be given a thin coat of shellac or varnish—enough to bring up the color but not to make anything shiny. I find a piece of ink eraser the best thing for removing shine from small surfaces.

On the upper parts aft and the headboards may be painted a characteristic design of that time, which is a pattern of triangles in black and white. I permitted myself some red triangles on the upper bulwarks and trail boards. None of this should be too bright and new looking.

TO RETURN to the deck: The mast holes should be bored next. Their positions may be seen on the deck plan. On the deck will be noted flat pieces representing the mast partners.

The hole for the mainmast will be $\frac{5}{16}$ in., for the foremast, $\frac{1}{4}$ in., and for the mizzen, $\frac{3}{16}$ in. in diameter. All must be on the center line, but at different angles with the water line; the main rakes one part in thirty parts aft; the fore, the same, only forward; and the mizzen, one in twenty aft. Cut two blocks of wood at the angles indicated to serve as guides in boring the holes. The assistance of some one to help you "sight" the bit will make this operation easier.

The bowsprit enters the forward deck to the starboard side of the stem; the hole is bored so that the heel will pass the foremast, yet the outer end will fall on the midship line. The diameter is $\frac{1}{4}$ in.

The main hatch is $\frac{5}{16}$ by $1\frac{5}{8}$ by $3\frac{3}{4}$ in. The sides should be made from $\frac{3}{8}$-in. wood, with their ends shaped to follow the camber of the deck. Their inside edges should be rabbeted to take the three gratings, which, however, may be in one piece, as previously described. Indeed, the whole hatch may be made in one piece, with the

(*Continued on page 115*)

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

The *Mayflower*

(*Continued from page 114*)

grating holes punched in or neatly painted.

There are three knightheads, but only the main and mizzen show. They are shaped as shown, with three fore-and-aft sheave holes and a staple on the port side. They are firmly set into the deck so as to rake with their masts.

Abaft the mizzenmast there is a fife rail set on four stanchions, and abaft that a little hatch over the whipstaff. It may have a grating or semicircular hood cover.

The capstan can be made from one piece of soft wood, with its long notches cut out with a penknife. The lower end extends and is set in a hole in the deck. This shaft actually had another capstan built onto it on the lower deck, but this does not show in the model.

Just abaft the foremast is a little hatch with two holes in it. These lead to the foreknight below. This hatch should not be fastened down until the halyards have been roved through the holes.

RIGHT across the fore end of the forecastle there is a pinrail with eight pinholes, and at the after end another, stopping short of the ladder positions, with six holes.

At the fore end of the half deck there is the belfry. A brass bell may be bought from a dealer in ship model supplies, or one can be turned from brass, lead or wood. Two little brackets extend level with the deck to take the forward posts for supporting the belfry. Make the four belfry posts, the sides and the roof and glue them together. Suspend the bell from a cross pin; then bore right through the roof and legs and drive pins through, to stick in the deck and the brackets. Running from the belfry to the ladders are short handrails, and a similar one extends across the poop deck.

Make the ladders as small as you can manage by gluing the steps into saw cuts in the sides, at an angle so that the ends and steps will be horizontal. Glue and nail them.

On the poop deck there are postlike cleats, set through boards between the timberheads, but ordinary cleats will serve.

In various positions shown between timberheads are cleats and pinrails. The shape of these can be seen in the deck plan (Blueprint No. 84). It is easiest to make a strip to the section shown, sawing it off to the right thickness and finishing it with small files or a penknife. These must be nailed through as well as glued. Some are upright, some horizontal. They will be needed to belay ropes to.

The shape of the guns and carriages can be seen in the deck plan and details. They should have a rope leading from eyebolts in the waterways through the holes in the carriages, and tackles back to ring bolts in the deck. To keep them in position, the eyebolts in the back ends of the carriages can go through into the deck. Similar guns may be set in behind the after upper gun ports, if the ports are open. All shutters should have ringbolts with lanyards leading into the hull.

The boat can be cut from the solid, or in two halves separated by a thin three-ply or solid wood keel, stem and stern, all in one piece. It should be hollowed and have thwarts, oars, mast, sail and rudder. Thin strips of rattan will make the gunwale moldings.

This should keep you busy until next month, when we shall start the rigging.

IF IT is desired to fasten anything to a brick wall with nails, drive them in a level mortar joint. If the wall is plastered, find a joint by driving a small trial nail at intervals in a vertical range of about 2½ in. When the joint has been found, nails may be driven to the right or left, or above or below at intervals of 2½ in. The safest way is to drill a ½-in. hole and plug it with ash, elm or spruce wherever the nails or screws are to be driven.—C.K.

"I was simply delighted—I 'KYANIZED' two bedrooms and the furniture in them. Then I 'KYANIZED' the kitchen and bathroom. In every instance the result was perfect. Anyone can transform both home and furniture with KYANIZE."
—Mrs. M. E. T. White, Calgary, Alberta, Canada.

Renew with Kyanize
Beautify with Decals

YOU can work miracles with Kyanize Celoid and a set of Kyanize Decals on those shabby pieces of furniture that seem so useless or out of date. Select the tint or color you prefer, then simply brush it on. It really isn't work. Then as soon as it is dry—it dries with a velvet-like, hand-rubbed surface—apply the Decals, which are exquisite floral and silhouette decorations. This can be done in a minute. All you have to do is wet the Decal with a little water and apply.

Kyanize Celoid Finish is very durable, waterproof and sanitary. It comes in a wide variety of tints and colors. On walls and woodwork it is easily and quickly applied, giving a long wearing finish—washable and sanitary.

Send 10 cents for the latest edition of our booklet in colors, "The Charm of Painted Things", or if your dealers cannot supply you with KYANIZE, send $1.00 for a special trial pint can with brush and booklet included.

Special $1.00 Offer

If your dealer cannot supply you, send us his name and $1.00. We will forward, prepaid, a full pint can of KYANIZE Celoid Finish (solid covering), a good brush to apply it and our new book, "The Charm of Painted Things"—all for $1.00. State color desired. CELOID TINTS: Sunset Pink, Orange, Havana Brown, Granite Gray, Gulf Blue, Mellow Cream, Niagara Green, Dixie Gray, India Buff, Pure White, Twilight Blue, Chinese Red, Pure Gray, Black.

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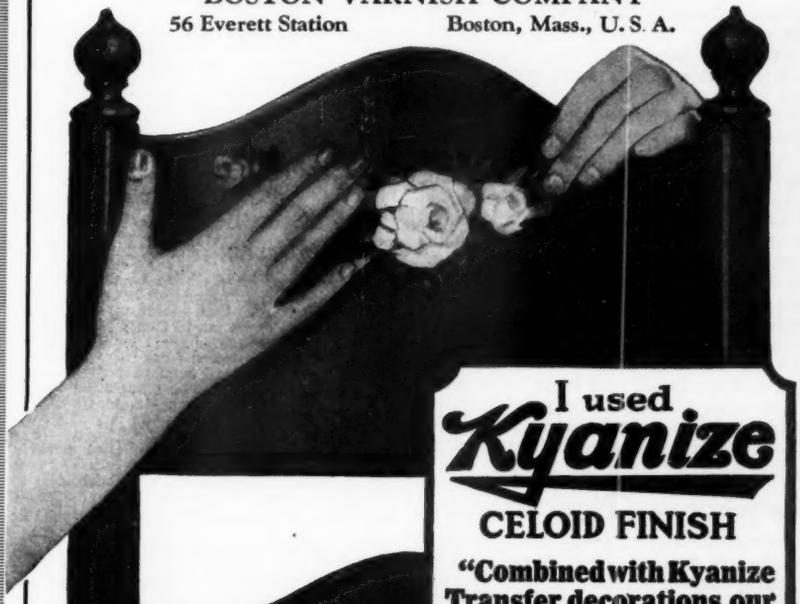

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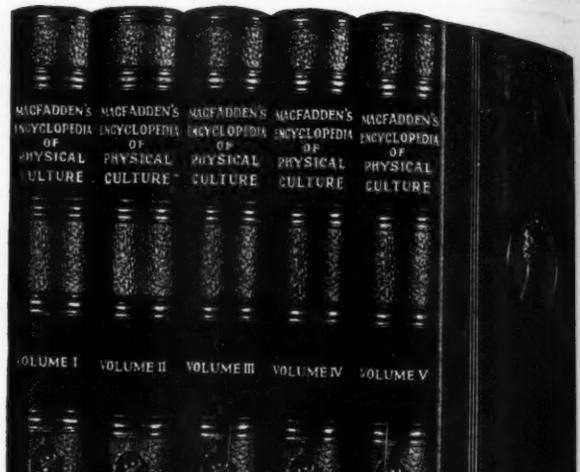
You can add 15 years to your life!

At least 60% of physical and mental misery is preventable and curable. In fact the life of the average person would be prolonged 15 years if people knew how to rule their health as they do their actions.



ENCYCLOPEDIA of PHYSICAL CULTURE
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FROM maturity to old age the breaking down or wearing out of vital organs is in process. But because there is no pain or noticeable symptoms the victim ignores the little signals of warning which Nature is constantly issuing until face to face with a dangerous disease.

When one is easily exhausted, even with a moderate amount of work—or suffers from headache, loss of appetite, a cold in the head or on the chest, a dull ache across the back, spots before the eyes, ringing in the ears, these are all signals, the neglect of which may lead to serious—perhaps fatal—illness.

Yet the cause of degenerative changes are preventable if taken in time. In fact, you can rule your health as surely as you rule your actions. Bernarr Macfadden, the world's outstanding exponent of physical culture, has, perhaps, had more experience than any other one person in guiding thousands from physical weakness and ill health back to wonderful health and vigor. Out of this great experience he has built

The Encyclopedia of Physical Culture

This marvelous work gives invaluable information on fasting, diet, exercise, and hydropathy for both health and beauty building. It gives thorough and extensive treatment of the laws of sex, the attainment of virile manhood and womanhood, and happy successful parenthood, together with details for correct diagnosis and treatment of all sexual diseases. It contains many handsome charts on anatomy and physiology.

It is neither dull nor technical, but is comprehensive and complete in every sense. It is the crowning effort of Bernarr Macfadden's rich, full experience in the science of health and physical culture. You haven't any idea how valuable it will be to you, or how many dollars it will help you save each year. What, for instance, would it be worth in actual dollars to you to be able to instantly identify in its earliest stages any sickness that might overtake you or any member of your family? What would it mean to you to have glorious health, almost complete freedom from sickness or disease, no doctor's bills to meet, no hospital bills to pay, no days of suffering or worry, no salary lost through absence from business?

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Thousands of letters have been written to Bernarr Macfadden commending his Encyclopedia of Physical Culture. One (name furnished upon request) says "Permit me to thank you for the great work by Mr. Macfadden—The Encyclopedia of Physical Culture—which I got from you some time last month. I have read much of it already, and consider it to be one of the best books on health ever published. I wish to thank Mr. Macfadden for his great work. The Encyclopedia is going to be my best doctor now and always."

Another man writes: "I cannot express the wonderful value of these great books and feel they will lead me to a successful married life, as I have recently married. They are a plain, sensible and priceless guide to a perfect physical life."

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Take ten days to examine the set. Then if you decide to purchase send us only $2.00 as your first payment. Additional payments may be made at the rate of only $3.00 a month until the total cost of $35.00 has been paid.

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THIS set of five volumes contains a complete education on Physical Culture and Natural Curative Methods—the equivalent of twenty comprehensive books on the following phases of health and vitality building:

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(5) A book on Exercise in its Relation to Health.
(6) A handbook on Gymnastics, with full instructions on drills and apparatus work of every sort, with hundreds of illustrations.
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Send me on 10 Days' inspection the five volumes of the Encyclopedia of Physical Culture. If I find the set satisfactory I will either send $2.00 in ten days and $3.00 a month until $35.00 has been paid, or $31.50 cash. If I decide not to keep the books I will return them in 10 days postpaid.

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This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Airplane Model

(Continued from page 82)

When finished, the propellers should be carefully sandpapered and balanced. If one so desires, the blades can be reinforced against splitting by covering two thirds of the blade length with China silk. The silk can be stuck in place with airplane nitrate dope or bamboo varnish.

To mount the propellers, cut two shafts 2½ in. long. Turn the ends into a tight loop and put each shaft through a propeller, sinking the loop into the wood at the hub to key the propeller in place. Install a copper washer, pass the shaft through the bearing, and turn a rubber hook on the remaining end with pliers. The propeller should be mounted so that the convex side is forward and the inner tips move upward when rotating.

THE main or rear wing spars are white pine $\frac{1}{32}$ by ⅛ by 30 in. There are eight ribs of bamboo $\frac{1}{16}$ by $\frac{1}{16}$ by 4 in. These are bent to an even curve ½ in. high, the highest point of the curve being one third the rib length from the leading edge. The two inner ribs are located 2 in. each side of the center. The remainder are spaced 4 in. apart, leaving an overhang at the end of the spars of 1 in. to which later are bound the tip outlines. The ribs are secured by putting a drop of glue on the spar at the proper place and then binding the rib with five wraps of silk thread each way.

The tip outlines, which are bamboo $\frac{1}{16}$ by $\frac{1}{16}$ in., are bound to the inner edges of the spars and extend 2½ in. beyond the ends of the spars. After the wing frame is constructed, align it and let the glue dry.

The front wing, or elevator, has spars of white pine a scant $\frac{3}{32}$ in. by a scant ⅛ in. by 9 in. There are three ribs of bamboo $\frac{1}{16}$ by $\frac{1}{16}$ by 3 in. The ribs are spaced 4 in. apart, leaving an overhang of ½ in., to which the outlines are bound. This wing is constructed in the same manner as the rear wing. The tip outline extends 2 in. beyond the spars.

The wing covering is bamboo paper. Put glue along the spars, ribs and outlines on the top side, press the paper in place and smooth out all wrinkles. Leave about ½-in. margin all around. After the glue dries, this may be trimmed away with a razor blade. Then give the entire frame, wings and propellers one coat of dope or two coats of bamboo varnish. As it dries, the coating will draw the necessary dihedral angle into the wings.

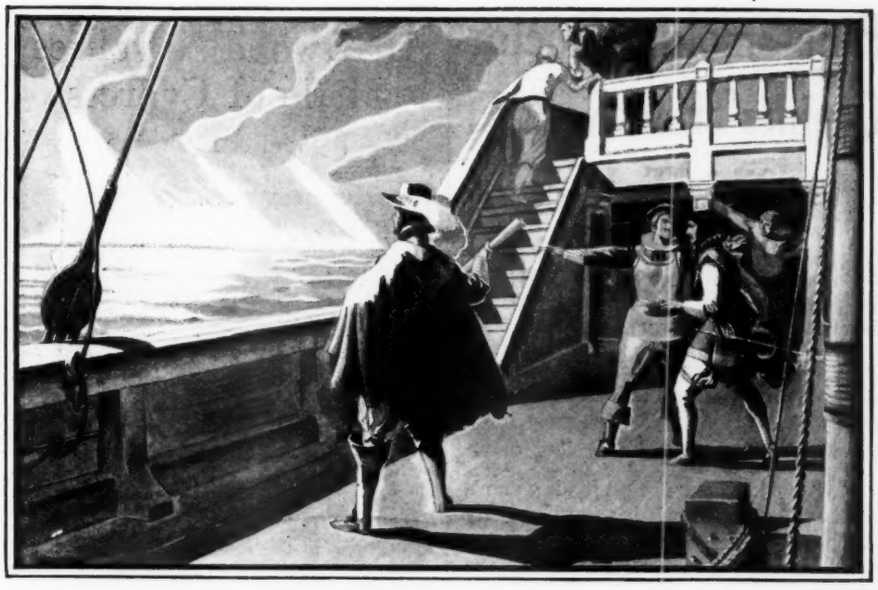
The wings are fastened to the fuselage by passing a rubber band under the fuselage and over the wings.

THE motor consists of four strands of $\frac{1}{32}$ by $\frac{1}{16}$ in. model airplane rubber to each propeller. This rubber can be obtained from any model airplane house, where you can also obtain bamboo, bamboo varnish and bamboo paper.

The motor can safely be wound 350 turns. Always launch the model with the wind. To fly the model, adjust the wings so it will make an easy glide to the ground. If the model climbs too rapidly and stalls, move the rear wing backwards; if it fails to climb, move the rear wing forward. After a few adjustments, the proper location will be found.

Two additional points might be mentioned for the benefit of those who have never made an airplane model. Bamboo can easily be bent by holding over a candle flame. The work on the propellers can be simplified by having the blanks cut on a band saw at a planing mill, or stock propellers can be purchased from a dealer in airplane model supplies.

Bunch and Koch recently astonished the old-timers at their aviation field by demonstrating a small seaplane model that rises from the water and flies a thousand feet. It will be described in an early issue.



Widening the Telephone Horizon

An Advertisement of the American Telephone and Telegraph Company

IN THE memory of many now living, Alexander Graham Bell made the apparently rash prediction that the day would come when we could talk to other countries, even across wide expanses of water. That was shortly after the historic conversation between Boston and Cambridge, a distance of two miles.

Bell's vision was made a reality when in 1926 New York and London spoke together in two way conversation, and when in 1927 this service was opened to the public between any point in the U. S. A. and Great Britain. Since then, Mexico has been brought into speaking distance; important cities of continental Europe have come within the voice horizon of the United States.

Even more important, the Bell System in the United States now embraces 18,500,000 telephones—a growth for the past year of more than 750,000.

We may now converse with each other from practically any point in this country to any other, and may talk beyond our borders and across the sea. That is measurable progress in widening America's telephone horizon.

NEW Boice Universal Handisaw

Now Boice has perfected another time and labor saver. It is amazing the work this machine will do.

Table. 15 in. x 17 in., elevates for grooving. Tilts 45 degrees for beveling. Swings 9-in. saw, cuts 2½-in. stock. Saw guard with splitter. Insert takes dado head 6 in. x 1 in., Cope Heads and 8-in. Sand Disc. Another insert provides opening for 2-inch Jointer Head. Jointer Attachment quickly fits on right of table. Machine as illustrated rips and joints boards 2 in. thick without stopping.

Other NEW low-cost attachments for the Universal Handisaw will PLANE BOARDS TO THICKNESS, mortise, shape, bore, tenon, drum sand, grind, disc sand, rout, polish and make mouldings.

Table Tilts 45°

Write for complete information and price of this Universal Handisaw. Also free 64-page booklet describing complete line of Boice Saws, Bench Saws, Jointers, Lathes, Drills, Mortisers and Jig Saws.

W. B. & J. E. BOICE, Dept. P. S. 5-D, Toledo, Ohio

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Pipe-smoking Doctor Claims Time Record for This Tobacco

Evidently we "started something" in publishing pipe-smoking records of old-time members of the Edgeworth Club.

Here is a doctor who writes in from Oregon to tell the world that he has smoked Edgeworth steadily and exclusively for a quarter century.

Any smoking tobacco that holds a man's affection that long must have some quality that commends it to others. Here's the letter in which Dr. Delepine claims the record:

St. Helens, Oregon
March 15, 1927

Larus & Bro. Co.,
Richmond, Va.
Gentlemen:

I notice with a good deal of amusement the challenge of Mr. J. J. Roberts of Columbia, S. D.

For my own part, I must confess to having smoked Edgeworth steadily for the last 25 years. I began before you had started putting up the "ready rubbed" kind, or at least before it was on sale in the Far West. I smoked your Plug Cut for two or three years. Then I switched to the "ready rubbed" as more convenient, but identical in flavor, and I have used it ever since.

So you may tell Mr. Roberts, with my compliments, that although he has done well and wisely, he is far from being the champion he fancies himself; and for my part, with my better showing, I expect to be a long way behind many others.

Yours very truly,
C. V. Delepine, M. D.

To those who have never tried Edgeworth we make this offer:

Let us send you free samples of Edgeworth so that you may put it to the pipe test. If you like the samples, you'll like Edgeworth wherever and whenever you buy it, for it never changes in quality.

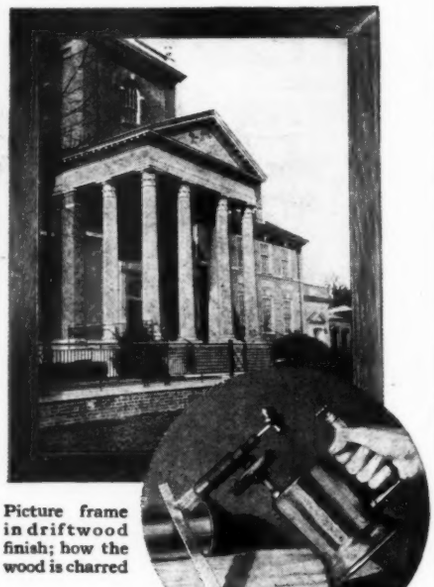
Write your name and address to Larus & Brother Company, 10 S. 21st Street, Richmond, Va.

Edgeworth is sold in various sizes to suit the needs and means of all purchasers. Both Edgeworth Plug Slice and Edgeworth Ready-Rubbed are packed in small, pocket-size packages, in handsome humidors holding a pound, and also in several handy in-between sizes.

[*On your radio—tune in on WRVA, Richmond, Va.—the Edgeworth Station. Wave length (254.1 meters) 1180 kilocycles*]

Driftwood Novelties Made of Cypress

By Walter E. Burton

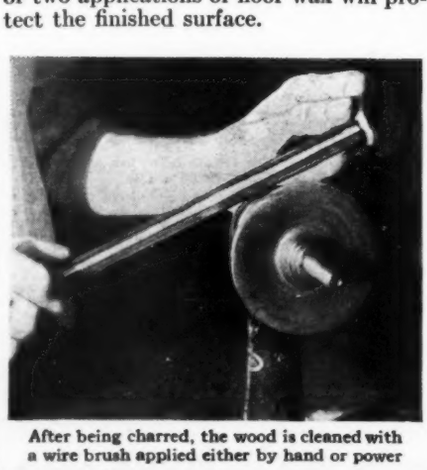


Picture frame in driftwood finish; how the wood is charred

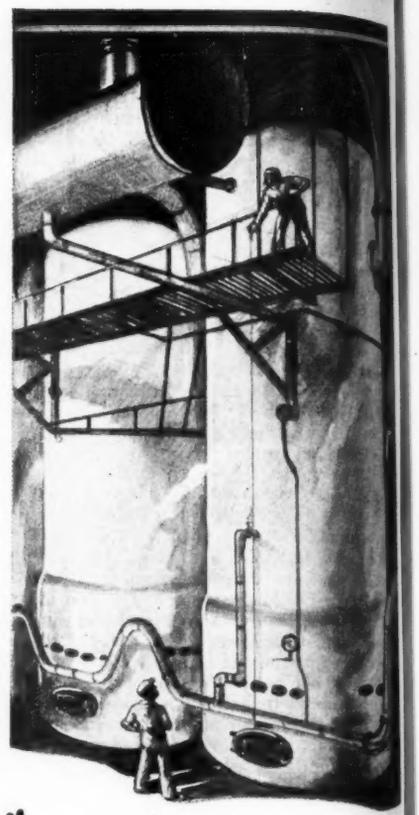
PICTURE frames, book ends, small boxes, and many wooden novelties may be finished easily to resemble Japanese driftwood. While almost any kind of wood that has a prominent grain will take this decorative finish, perhaps the best is cypress. Most home workers are familiar with this soft, easily worked but astonishingly durable wood. Those who are not should add a few boards of it to their lumber rack and become acquainted with its general utility.

For a picture frame, cut the wood into strips of the desired size and rabbet (groove) them to receive the glass, picture and backing. Apply the flame of a blowtorch to the surface on the front and both edges of each piece until a thin, even layer of charcoal is formed; then remove the charred wood with a wire brush or with a stiff scrub brush, leaving the hard, less-burned grain standing out in relief against the softer portions.

A thin coat of shellac followed by one or two applications of floor wax will protect the finished surface.

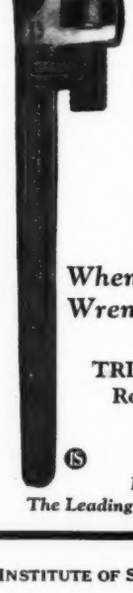


After being charred, the wood is cleaned with a wire brush applied either by hand or power



"Hey Joe! Give Me My TRIMO"

When stiff pipes refuse to turn, the mechanic who knows his job calls for a TRIMO.



All steel construction and careful manufacture make TRIMO the leader among pipe wrenches.

Replaceable insert jaws and handy nut-guards to keep the adjustment true are features of every genuine TRIMO.

When You Want a Pipe Wrench, Buy A TRIMO

TRIMONT MFG. CO., INC.
Roxbury (Boston), Mass.

TRIMO

For Forty Years
The Leading Wrench Makers of America

A Movable Saw Table

(Continued from page 80)

until it will admit a hack saw blade. It is then easy to saw the ⅜ in. wide slot down to the end screw hole, and smooth it up with a file. If the butt hinges on the other end of shelf are of the loose pin type used on doors, removing the two adjuster bolts and pulling these pins will permit the motor and shelf to be taken out.

I screwed down my motor and saw temporarily on a heavy plank and used it to make all the saw cuts on this job, which shows what heavy work a ¼-H.P. outfit will do.

Iron screw clamps are invaluable to hold the parts rigidly together while boring. Use the steel square to check all corners before you bore. I assembled the sides first, with cam rails and aprons; then I joined the side assemblies with the top and middle stringers across the ends. The motor shelf is next fitted in, and then the top screwed on.

THE shape of the cams is very important. On a piece of stiff, smooth cardboard lay out radii spaced at 30 degrees, and from the center lay off the measurements given. This will give you a series of points through which a smooth curve can be drawn. Cut out the cardboard and use it for a pattern. Note particularly that the lowest point of the cam, when the lever is pushed down to the stop (which is simply a stout wire nail put through the cam rails), comes ¼ in. beyond the vertical center line. This makes the cam self-locking.

As shown, the cam consists of a center section with two cheek pieces glued on, the grain crossing at right angles. My purpose in this construction was to guard against splitting. It would be less work and probably safe enough to cut them all in one piece out of oak or other hardwood 1⅞ in. thick, if you can get it. They should be cut on a band saw, and the face smoothed on a sanding disk. It is imperative that the hole should be exactly where indicated and absolutely square in relation to the sides. That means boring in a drill press. It is safest to put through a pilot hole first, on the exact center, with a small drill (say $\frac{3}{32}$ in.) at very high speed. The larger bit will follow this pilot.

It is also important to get the bolt holes through the cam rails accurately located and square. Cams and rails should be painted and dry before assembly. Grease the cam bolt, also the working face of cam. Then grease the bedplate tenons and their grooves, tilt up one side of the table, and slip the bedplate in place. Do the same on the other side.

Incidentally, don't forget the ⅛-in. clearance between bedplate and rails or omit the sheet metal wearing strips.

The electrical work is very simple. Motor wires are run to a porcelain fuse cut-out block screwed to the underside of table, one wire passing through a tumbler switch mounted on the front of bench. The ten-foot extension cord connects to the fuse block.

The framework is finished in gray and the top, including aprons, in buff. It is well to finish the top of any worktable (if not to be used for very dirty work) in a light color.

Stock Bill for Saw Table

Lumber—1 pc. 2 by 4 in. by 12 ft.; 1 pc. 4 by 4 in. by 10 ft.; 1 pc. 2 by 8 in. by 8 ft.; 1 pc. 1 by 4 in. by 16 ft.; 1 pc. 2 by 12 in. by 2 ft.; 1 pc. 4 by ⅝ in. net by 4 ft. (must be hardwood).

Hardware—16 ⅛-by-4-in. carriage bolts; 8 ⅛-by-5-in. carriage bolts; 4 ⅜-by-4-in. carriage bolts; 2 ⅜-by-2-in. machine bolts; 12 2½-in. No. 14 flathead screws; 8 1½-in. No. 12 flathead screws; 1 pair 3-in. loose pin butt hinges; 1 pair 5-in. strap hinges; 1 set (4) ball-bearing truck casters, 2½-in. wheels.

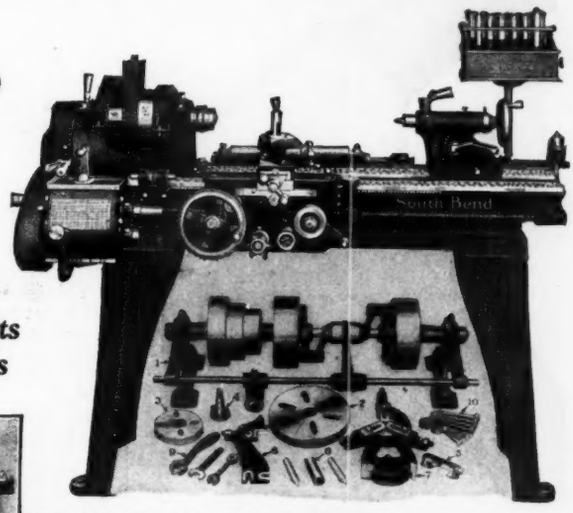
Electrical—1 porcelain fuse cut-out block, 2 10-amp. fuses, 1 porcelain base tumbler switch, 5 ft. No. 12 wire. Extension cord and plug, if not included with motor.

Finish—¼ pt. buff and ½ pt. gray brushing lacquer or floor varnish.

SOUTH BEND LATHES

FOR
Tool Room
Manufacturing
Machine Shop
Repair Shop
Service Station
Laboratory
Engineering Shop

Ⓘ



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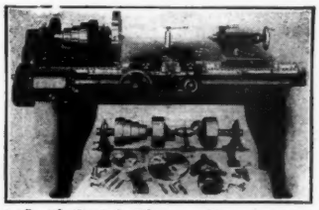
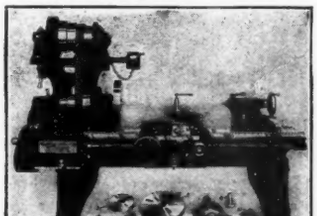
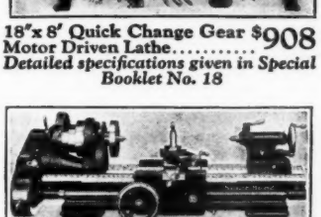


11"x4' New Model Precision Tool Room Lathe with Countershaft and Regular Equipment..... $335
One of the types illustrated in Special Booklet No. 11



16"x 8' Quick Change Gear Lathe, Straight Bed..... $570
Described fully in Booklet No. 16



18"x 8' Quick Change Gear Motor Driven Lathe..... $908
Detailed specifications given in Special Booklet No. 18

9"x 2½' Junior Back Geared Screw Cutting Bench Lathe. $150
Shown complete in Booklet 22K

16"x 6' Quick Change Gear Gap Bed Lathe..... $620
Shown complete in Booklet No. 16

Other Popular Selling Sizes

The Prices of Popular Selling Sizes with Countershaft and Equipment

Size of Lathe	Shipping Weight	Standard Change Gear	Quick Change Gear
9" x 3'	490 lbs.	$235.	$270.
11"x 4'	725 lbs.	$300.	$335.
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Saxophone gives you these extra features—Snap-on Pads, greatest improvement, easy to replace, no cementing—Patented Automatic OctaveKey—perfect Scale Accuracy—convenient key arrangement.

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playing a sweet-toned Buescher. 10 evenings—one hour each—will astonish and please you. 6 days' trial. Easy payments. Mention any other instrument in which you are interested. (450)

Buescher Band Instrument Co.
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"I've been using this same Maydole as long as I can remember and it's still sound and strong. You just can't wear it out and I've yet to see a hammer that can equal it for 'hang' and that it won't easily outdrive and outpull."

The Maydole Hammer of today represents the finest that modern methods and equipment plus eighty-five years of specialization can produce. Its press-forged tool steel head and clear, second-growth, air-dried hickory handle wedged on "for keeps" will stand a terrific amount of hard use.

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Announcing The Norwich Ball Pein Hammer

A new, drop-forged Ball Pein Hammer with a beautiful 'hang' at a price that makes it a wonderful value. An ideal extra hammer for home shop, garage or farm. Ask your dealer to show you the Norwich Hammer.

YOUR HAMMER SINCE 1843

Maydole Hammers

The David Maydole Hammer Co. Norwich, NY

1650

Dick Byrd, Adventurer

(*Continued from page 15*)

June, 1912, he received his diploma from the hand of the President of the United States.

He went to sea, an ensign, U. S. Navy. But not for long. Month by month he suffered more and more pain from his patched-up ankle. Standing watch became exquisite agony. Worming his way through narrow turret hatches was almost a physical impossibility.

To cap the climax, one day in a heavy sea he fell down a steep ladder leading from the battleship's quarterdeck to her starboard gunwalk. Once more he cracked his leg.

This time the surgeons shook their heads.

"What's the use, Byrd? You are not fit for standing watch. In a seaway you may have another accident like the one through which you have just passed. The best thing for you to do is to go on inactive duty."

In 1916 he succumbed to the inevitable. He was retired as a lieutenant; put on the shelf.

BUT Dick Byrd is the last man in the world to stay on the shelf. War came. Against the advice of friends and doctors he insisted that he be given a chance to learn to fly.

Even a willing cripple was valuable in war time. So Dick Byrd was sent to the Navy Air Station, Pensacola, Florida, for instruction.

His student days in the air were full of thrills. A plane nose dived and killed both occupants right before his eyes three minutes after he set foot at the station. His plane stalled the first time he went into the air alone. He collided with another plane at eighty miles an hour and lived to tell the tale.

As soon as he had the necessary experience he got permission to do some flying out of sight of land. In those days no one thought of doing such a thing. First, flyers hadn't learned to navigate in the air; and second, planes were so flimsy and engines so unreliable that such flights were only welcoming death.

At this time Byrd devised the first instruments and developed the first methods for navigating an airplane out of sight of land.

FROM Pensacola he was ordered, in August, 1918, to Halifax to command a submarine patrol station and prepare flyers for duty abroad. When the Armistice came he was teaching men how to jump out of planes in parachutes. In 1921 he helped organize and flew part of the way with the Navy's first trans-Atlantic flight via the Azores.

All this time he was nursing two great ambitions: to fly without stopping from New York to Paris, and to circle the North Pole by air.

Theodore Roosevelt refused to let him do the former. "We need you, Byrd. Wait until we have an engine that will run longer and keep going."

The latter plan, a polar flight, was killed by Congress when the *Shenandoah* was not allowed to leave in 1924.

Byrd, fretting at inaction, asked to join the *ZR-2*, the big British dirigible being built at Howden, England, and about to be delivered to the United States Navy.

He got his orders, hurried to London and reported at the Embassy.

"Test flight tomorrow, Byrd," said the attaché.

"May I go?"

"If you can get them to let you aboard. Not many places left. Try if you want to."

Eagerly Byrd hurried to Howden. Probably it never entered his mind that a test flight of a new airship so huge was charged with danger. Little time Byrd spends on thinking such thoughts.

But his effort was in vain. The *ZR-2's* complement was filled. "Never mind," Commander Maxwell, the American senior, told him. "You are flying to America with us."

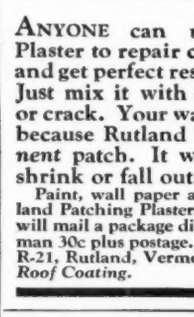
That afternoon the *ZR-2* broke in half and exploded over the

(*Continued on page 121*)

The *handiest* Patching Plaster

ANYONE can use Rutland Patching Plaster to repair cracked walls or ceilings, and get perfect results. No muss or bother. Just mix it with water, and fill the hole or crack. Your wall will be as good as new because Rutland Plaster makes a *permanent* patch. It will not crack, crumble, shrink or fall out.

Paint, wall paper and hardware stores sell Rutland Patching Plaster. If your dealer hasn't it, we will mail a package direct and you can pay the postman 30c plus postage. Rutland Fire Clay Co., Dept. R-21, Rutland, Vermont. *Also makers of Rutland Roof Coating.*



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is a combination Mannheim, Polyphemic, Log-Log, Binary, Add and Subtract Slide Rule. It will instantly add, subtract, multiply and divide any combination of whole numbers, fractions, mixed numbers and decimals. Gives every root and power, also Logs, Sines and Tangents. Made of aluminum with scales on white celluloid. Size 4 in. Approved and adopted by colleges. Price with instructions, $1.50. Leather Case 50c extra. Sent C.O.D. if desired. Catalogue Free. GILSON SLIDE RULE CO., Stuart, Florida

(Patented 1-17-22)

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Dick Byrd, Adventurer

(*Continued from page 120*)

Humber River. Byrd's task by cable was searching for the mutilated bodies of his friends.

In 1925 he got permission to take three Navy planes to Greenland. He got away from New York in the summer of 1925. He had been warned against using an airplane in the far north. His men were not familiar with northern conditions. None had worked in snow and bitter winds. Byrd, a slight figure at best, was not built for cold weather.

By the time his ship reached Etah, the little Eskimo village in northwest Greenland, there were but twelve days of summer left. Only three of these proved fit for flying.

There were other obstacles and handicaps. One plane burned. Another was smashed by an iceberg. Beach proved too small for taking off.

He took off three days after arrival and flew again and again westward toward the blank space in the map between North America and the Pole. But he was failing—geographically, that is. In his knowledge of the north he was winning every desperate day he put in.

AFTER his planes had covered more than 6,000 miles of Arctic territory he retreated south. He had discovered no new land. But he had learned how to fly in polar regions.

He at once announced his intention of flying to the North Pole. By hard work and his own enthusiasm he collected $30,000, borrowed a ship from the U. S. Shipping Board, bought a Fokker plane on the installment plan, and sailed for Spitzbergen in late April, 1926.

On May 9th, shortly after midnight, he and Warrant Machinist Floyd Bennett, his pilot, set forth in their monoplane from King's Bay, Spitzbergen, and headed for the earth's northern axis. Both knew that if their engines stalled they would die of cold and starvation on the ice, if they were not killed in the crash.

Just before reaching the Pole one engine began to leak oil. Byrd's sextant fell off his table and broke. They were nearly a thousand miles from the nearest help.

"Shall we turn back?" said Bennett's look.

Byrd shook his head and smiled. And when Dick Byrd shakes his head and smiles, men go through hell for him without another thought.

The plane circled the Pole. By a miracle the faulty engines kept going. By another miracle, in the shape of Byrd's sun compass, he found Spitzbergen again without his sextant.

Twelve months later he had another plane and was ready to fly to Paris. Through no fault of his own the plane cracked up on her test flight. Bennett and Lieut. George O. Noville, U. S. Naval Reserve, the latter of whom accompanied Byrd on his flight to France, were nearly killed. Byrd escaped with a broken arm and a split rib. This setback prevented him from being the first man to fly from continent to continent without a stop.

AT THIS writing he is getting ready to fly across the South Pole. He will succeed. He always succeeds—in the end.

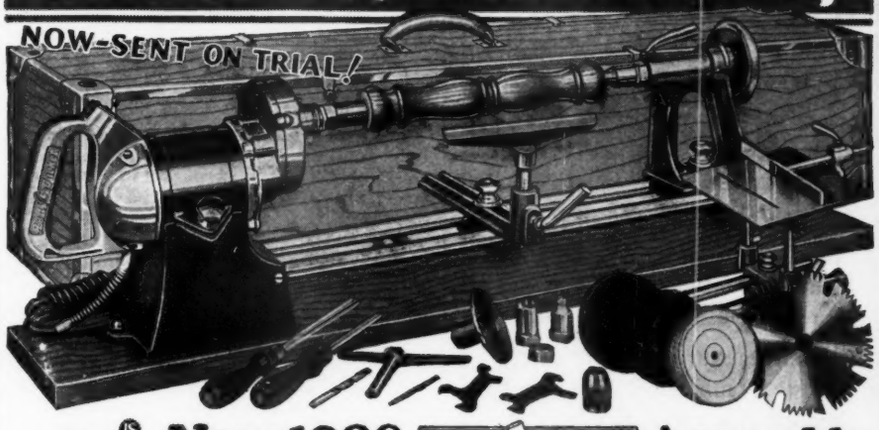
There is no fuss or flurry about his preparations. He is going to spend $600,000 and try the most dangerous and difficult piece of exploration ever planned. He is going to take a ship, maybe two; a hundred dogs; provisions for a year and a half. He must pick thirty men from thirty thousand applications.

Yet he is doing it all with the help of only one or two others, doing it quietly and efficiently. And when the day comes to hop off for the greatest unknown area on the globe today, he will "give her the gas" with a smile on his face and a gay wave of his hand.

For the smile and the wave, the quiet efficiency, comprise Dick Byrd, adventurer.

Next Month—another thrilling chapter telling of the adventures and triumphs of this flying crusader of science.

The Modern Craftsman's Wonder Shop



New 1928 Red Jacket Assembly

Five Thousand Red Jacket Craftsmen have made a bargain possible for you

Without Waco sales volume, no manufacturer could give the equivalent of "*Waco Shop No. 18*" at its price—*A Red Jacket Master Drill*, the *Waco Craftsman's Lathe*, the *electric power tools*, the *Jig Saw*, the *Red Jacket Band Saw*, or the Crafts Courses.

This equipment was designed, tested, approved and is guaranteed by Wm. L. Aylward, a nationally known craftsman and manufacturer, who has developed his hobby into a co-operative association of five thousand craftsmen.

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Write or send coupon at once for valuable information to all interested in beautiful handiwork. It is free. It tells you how easy it is to operate a Red Jacket set of tools and lists the advantages and privileges that are free to member craftsmen. Don't miss knowing all about Waco. It is free. You are invited.

Look out for imitations. There is only one Red Jacket—one Waco—one Wm. L. Aylward, Mastercraftsman.

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Special Crafts Course FREE

SPECIAL CRAFTS COURSE and blueprint service is free to Red Jacket Shop owners—all that there is to know about handicraft methods, raw materials, woods, carving, sawing, turning, designing, carpentering, decorating, is taught by special correspondence.

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Manager, Dept. 5. Please send me all free information and literature on Red Jacket Assemblies.

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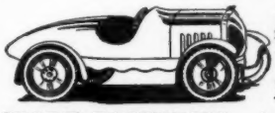

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[ ] Send adding machine C. O. D. $2.50 plus postage.

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AGENTS Write for big commission and exclusive territory proposition.

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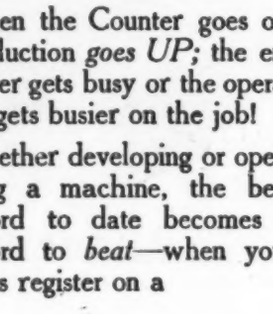
Dial Your Goal; Watch Your Gains

IS there any machine that can't be improved—or better operated? It's not so recorded on a *"Veeder"* dial.

When the Counter goes on, production *goes UP;* the engineer gets busy or the operator gets busier on the job!

Whether developing or operating a machine, the best record to date becomes a record to *beat*—when your gains register on a

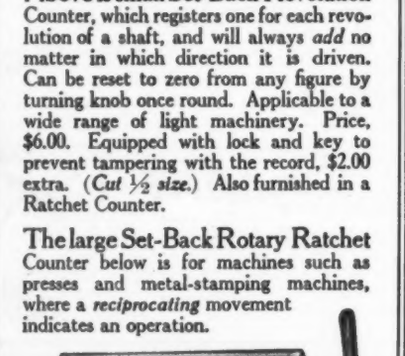
Veeder COUNTER



Quick Re-Set

Above is small Set-Back Revolution Counter, which registers one for each revolution of a shaft, and will always *add* no matter in which direction it is driven. Can be reset to zero from any figure by turning knob once round. Applicable to a wide range of light machinery. Price, $6.00. Equipped with lock and key to prevent tampering with the record, $2.00 extra. (*Cut ½ size.*) Also furnished in a Ratchet Counter.

The large Set-Back Rotary Ratchet Counter below is for machines such as presses and metal-stamping machines, where a *reciprocating* movement indicates an operation.



Registers one for each throw of the lever and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figures, as illustrated, $11.50—subject to discount. (*Cut less than ½ size.*) Set-back *Revolution* Counter of similar model, $10.00 (list).

The Veeder booklet shows instruments that "count everything on earth." See them—by sending for the book.

The Veeder Mfg. Co.
44 Sargeant St. Hartford, Conn.

Puzzlers Meet in War of Wits

(*Continued from page 38*)

husband-and-wife teams at the convention.

Most picturesque, perhaps, was "Remardo"—Edwin Smith, a retired farmer of Ardmore, Pa. Totally blind and deaf, he managed to greet each of his fellow puzzlers by name. A young niece, holding his hand, communicated their identity to him by an ingenious code he himself had devised. At lightninglike speed her fingers flew over his. Four fingers grasped, that meant "W;" two fingers, "T;" "L" and "J" were marked with her forefinger on his palm. So the alphabet was completed.

A novice at the puzzlers' convention feels he is in a foreign country hearing a strange language. "Wreck"—that was one of the first words that mystified me. I learned that it meant an incomplete, temporarily abandoned puzzle. Other terms of the puzzlers' curious vocabulary were explained to me. "Flattist" is a person who makes puzzle in verse. The world of puzzles and their makers is "Puzzledom," "Thedom," or simply "Dom." Puzzlers as a group are the "Krewe," and "slipping" is the first stage in the making of a "word form," ancestor of the crossword puzzle, in which the words are copied separately on a slip of paper.

ON PAGE 38 appears one of the best of the word forms the puzzlers showed me—one on which you can try your own wits. No. 4 may send you to the dictionary, but the other words are not difficult. If you can solve it, as you would a crossword puzzle, you will have a diamond of letters that spell the same words across and down. If it had used different words, across and down, the puzzlers would call it a "double diamond." Squares, arrow-shaped figures, polygons, stars—there is no limit to the shape in which these form puzzles may be made.

You will notice, too, that this sort of puzzle has no black squares, such as the crossword puzzler puts in when he cannot join words.

"Crossword puzzles are mere child's play to make," said "Arty Ess," editor of the puzzler's official magazine, *The Enigma*. In business life he is Rufus T. Strohm, vice-dean of a correspondence school. "We believe our 'glorified crosswords,' or word forms, have infinitely greater possibilities, though they are much harder to construct. Of course it is often necessary to resort to obscure words. We don't care where the word comes from, so long as there is authority for it. We have chosen a dictionary, a gazetteer, and a biographical work as standard references, but we may use a word from any other source if that source is mentioned. That helps to make our puzzles interesting and educational. They contain not only simple words, but odd ones like 'yolts' and 'terpinene' that are worth knowing. And we rule out all the abbreviations that the crossword puzzler uses, because they are meaningless and have no practical use."

MOST of the puzzlers are interested in words and in word puzzles to the exclusion of all other kinds. Word forms are only one type of these. "Cryptograms," or messages in code; "anagrams," in which the letters of a word or phrase are rearranged to make an entirely different one; riddles, charades, and enigmas are food and drink to the puzzler.

"A puzzler is like an author," said "Zoroaster"—L. C. Macaran, of Philadelphia. "He may have an idea, and start work on it, any one of the twenty-four hours of the day." And "Nypho"—H. C. Wiltbank, rare book dealer of Washington, D. C., agrees with him. "Sometimes, for instance," said Nypho, "a puzzler may get a (*Continued on page 123*)

An idyl of an idling stream

A POEM of motion, the "Old Town" glides across the mirror stream. . . . Reflections dance on tiny ripples. . . . Colors blend and clash in riot. . . . At a stroke of the blade the canoe darts forward, swift and smooth and light.

"Old Towns" are patterned after actual Indian models. Their graceful lines mean steadiness and easy handling. Priced as low as $67. From dealer or factory.

New catalog gives complete information about sailing canoes, square-stern canoes, dinghies, etc. Also fast, seaworthy boats for *Outboard Motors*. Write for free copy today. OLD TOWN CANOE CO., 1895 Main Street, Old Town, Maine.

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It is the only known solder for aluminum and has been used successfully with radios, steam pipes, automobile radiators, cracked cylinder heads, gasoline tanks—in fact, any place a solder is used.

TISIT belongs on every work bench, in every garage, in every home, where it pays its small initial cost many times over.

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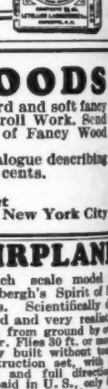

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CHICAGO STOCK GEAR WORKS
105 South Jefferson Street Chicago

Puzzlers Meet in War of Wits

(Continued from page 122)

chance idea from a sign he sees on the street, or a newspaper he is reading, wherever he happens to be. Suppose his eye falls upon the printed word 'reduction.' Immediately the thought pops into his mind to twist it around into an anagram and make 'introduce' of it. To a puzzler, who lives in a world of words, that is easy.

"A New York lawyer made the best anagram I know of," Nypho told me, "by turning 'the eyes' into 'they see.' Some other choice ones are: 'received payment,' 'every cent paid 'em;' 'the green eyed monster,' 'the ogre enters my Eden' and one fellow who really meant it transformed 'the boarding house' into 'this abode o' hunger!'"

How long does it take to make up a puzzle?

"I've dictated to a puzzle editor, over the phone, a puzzle I've made up on the spur of the moment, after he had S O S'd for something to fill a hole in his column," said Nypho.

But the secretary of the Puzzlers' League, "C. Saw,"—otherwise Lewis Trent, a high school teacher of New York—gave another side of the picture. "Some of these word form puzzles," he told me, "have taken ten, fifteen, or even twenty years to construct! When the maker gets stuck for want of some odd word that will fit he lays aside his 'wreck,' perhaps for years, until he happens to come across the desired word in some obscure reference."

Classifying and indexing all the eight-letter words in the English language, as an aid to makers of word squares, was the colossal task completed by the late Walter S. Kaye, finger-print expert in the adjutant-general's office at Washington, D. C. A hundred puzzlers, searching a hundred dictionaries, biographies, and atlases, supplied him with the thousands of standard words, names of persons, and place names which he compiled in a mimeographed list according to their endings. It is available to all puzzlers.

One word, however, lacking dictionary authority, is not there; and it was the subject of an amusing incident at the convention meeting I witnessed.

"I move," proposed a puzzler, "that the Century and Webster dictionaries be formally urged to include the word 'carefree' in their vocabulary!"

"Why?" the chairman wanted to know.

It developed that the puzzler needed just that word to complete an eight-letter word form he was making. And the motion was passed!

Solutions to Puzzles on Page 38

The words of the cryptogram should read:
UNDERLINGS WITH FACULTY OFT CLIMB PAST THICK COMPANY; EMPLOY SHARP, EXACT WATCH; COP EMPTY JOB ALOFT.

The diamond of words is as follows:

M
FOR
HOLED
FORETOP
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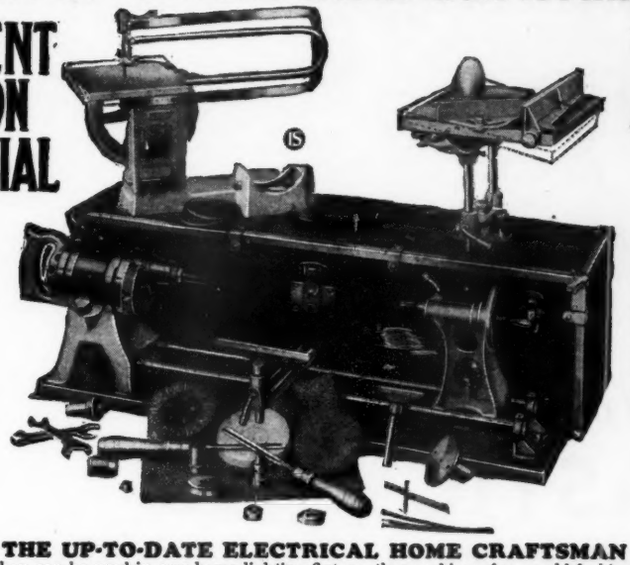

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1 lb. can $1.00 ¼ lb. can 35 cts.

At Hardware and Paint Stores

ADDISON-LESLIE COMPANY
302 Bolivar Street Canton, Mass.

Attic Inventor's Magic Eye Sees Across the Ocean

(*Continued from page 41*)

adjoining room he threw a switch and the dummy's face appeared on a screen before the visitor's surprised eyes! The first step in television had been accomplished. As a result of this experiment the inventor likewise produced his so-called "noctovision," by which a beam of light can penetrate fog.

Baird continued working feverishly until, late in 1925, he almost reached the end of his string. Then it was that he encountered Captain Hutchinson. The Captain recalls:

"I was shocked at his condition. His clothes were patched and worn; his shoes were full of holes. His hair hung to his shoulders. He was weak from exhaustion, and hadn't eaten a full meal in months."

AIDED by Hutchinson and with new equipment, Baird had a television apparatus ready for demonstration in six weeks! British scientists had been skeptical, so when Baird, in January, 1926, invited members of the British Royal Institution to his first demonstration, he hoped for only a few.

Actually forty distinguished scientists and engineers crowded, by relays, his little attic and saw their own faces transmitted.

The scientists marveled at his contraption of soap boxes and biscuit tins, bicycle chains and sprockets, lamps and lenses, as shown in last September's POPULAR SCIENCE MONTHLY. He had made a set of rapidly revolving disks to focus the light from a face into the transmitting apparatus. One disk fitted with lenses revolved 500 times a minute in front of the subject's face. A second disk, revolving 5 000 times a minute, caused an interruption of the light traveling from the lenses, and the interrupted rays where led into a colloidal cell. The light impulses passing through the disks were converted into electrical impulses which were led into a radio transmitting apparatus. The receiving set was in effect the transmitting device in reverse.

Baird's next step was to devise a cell that would be sensitive to a very weak reflected light. But how? Hear him tell it:

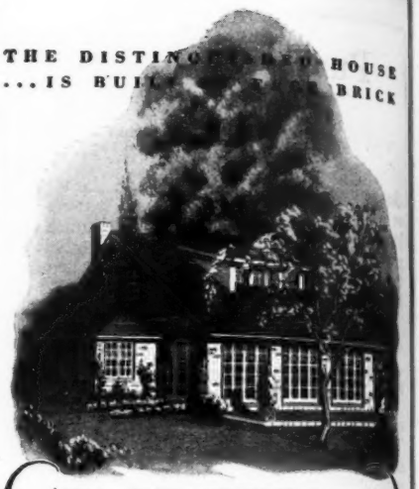
"Dissatisfaction with the selenium cell and lens made me feel that television demanded something more refined. The most sensitive optical substance known is the nerve of the eye, called the visual purple.

"I made the rounds of the hospitals. Finally I learned that a surgeon had removed the unimpaired eye of a boy. I pleaded until I got it. Then I jumped into a taxicab, went to my laboratory, and in a few minutes had the eye in my machine. The essential image for television passed through the eye within half an hour after the operation."

The eye was "dead" a few hours later, but the study of it enabled Baird to produce an extremely sensitive photo-electric cell, the composition of which he has kept secret.

EARLY in February of this year, Baird sent the first television pictures of a living, moving face from his London laboratories (not an attic) to the home of R. M. Hart, a radio amateur of Hartsdale, N. Y. History was made. The soap box contraption was placed with ceremony in the British Science Museum, between the first steam railroad engine and the Wright brothers' first airplane.

Baird's success has brought him at least one luxury—an office boy whose sole duty is to retrieve his spectacles, without which he practically is blind, from wherever the absent-minded inventor leaves them. And now he is setting himself to tackle a new problem. He firmly believes that the Einstein theory of relativity is "a fallacy and based on a fallacy." He hopes to prove it!



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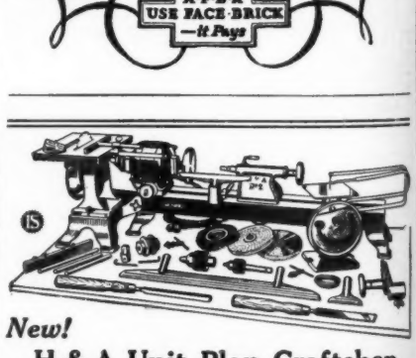

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HESTON & ANDERSON 805 Western Ave. Fairfield, Iowa

The Electric Pilot

(Continued from page 24)

across the field, and rose quickly. Dick frowned as he watched the plane mount higher and higher.

"Confound Jack," he muttered, "there's no reason for getting out of sight!" Marian watched anxiously as Dick went into the office building and emerged a moment later with his binoculars. She saw his mouth tighten as he nervously focused on the speck in the sky.

"Doesn't look very steady to me," he observed, "but maybe the inspector is putting her through some new tricks."

A few minutes later the silver *Dragon Fly* had landed, with a slight rebound, as though she had not quite straightened out when the wheels struck. Dick and Marian were at its side almost as the propellers stopped. Dick looked inquiringly at Captain Perkins.

"Sorry, Warner," said the inspector with a perplexed frown; "it didn't do its stuff. I had Graves switch it on and off several times, but the plane acted as though it were out of control entirely. He had to grab the stick to get her on an even keel."

JACK, without a word, swung out of his "pigeonhole" in the narrow cockpit. He busied himself with his parachute, loosening it with awkward fingers, and then made for the hangar a few rods away. Marian followed.

"I don't understand it, Captain," said Dick tensely. "You know how beautifully she worked half an hour ago. A child could work those buttons. Are you sure the switch was on?"

"It sure was," snapped the inspector, "that was the main reason for a switch marked 'On' and 'Off.' Look her over and see if you can find the trouble. Might be something that can be easily fixed. But it *is* disappointing to find it gets out of commission so easily. Our pilots need a device like this, too—one cracked up only yesterday. But it's got to be dependable." He swung away to the office, and Dick made his way to the hangar. As he approached, the angry voice of Jack floated out.

"I tell you, I'm as sober as a judge. This world-beatin' rig didn't work, that's all. I don't know what the kid engineer did this morning, but his dummy pilot was no-go this trip. You'll find out that this pilot knows his stuff."

Marian's voice followed. "I don't believe it," she said with conviction. "It worked for Dick, and it will work for anyone who will let it."

"WHADDYA mean, let it? I turned the switch on, didn't I? Ask the captain. No one but a guy that had lost his nerve would want a rig like that, anyway. Of course, if you've made up your mind this nut is perfect. . ."

Dick stepped forward and cut in on Jack's protestations.

"Could you stay tonight and go over the whole thing?" he queried, with a voice that, in spite of himself, was spiritless and heavy.

"Can't tonight," said Jack carelessly, as he walked to the door. "Gotta party on. Don't know anything about the rig anyway. Hope you get 'er fixed."

Dick turned to Marian, and smiled wryly, the best he could muster to reassure her. "Would you stop at the shop and have Swanson sent over? Guess we'll have to stay with it, if it takes all night. Captain Perkins said he had to make a report tomorrow on the control."

She nodded, and patted his shoulder. "It'll work out all right. Better get some sleep. Lots of things can be slept off—" and she glanced at the retreating form of the test pilot.

Dick was splashing water over his head when Marian came in the next morning. He was tired and worried.

(Continued on page 126)

JOHNSON HAS GIVEN WINGS TO WATER TRAVEL

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Return this coupon for a FREE copy of Booklet

The Electric Pilot

(*Continued from page 125*)

"You haven't been up all night?" she accused.

"Yes," he admitted. "Just trying to wake myself up. I worked right through and just came back from a spin. When Jack comes I'll have him take it up and try it."

"What did you find?" she asked eagerly.

"Not a thing. That's what worries me. The control was in perfect shape. We checked every part, and it ran as well as ever this morning."

"Then, there's nothing to worry about?"

"Yes, there is. If it goes out of kilter like that with no apparent cause, it may mean a fundamental weakness in design that it may take months to overcome. I haven't been able to think what it might be." He leaned tiredly against his desk.

MARIAN spoke suddenly. "Have you thought that Jack might be to blame?"

"I had wondered a little about him. But I haven't been able to hit on anything he could do that a good pilot like Perkins wouldn't have seen. No, I don't think he would do us any dirt. Why should he? When he comes, he can take it up alone and I'll stay down and take his report over the radiophone."

"I felt uneasy about him, yesterday," said Marian. "He seemed so sure it wouldn't work. And," she continued, flushing, "he has been jealous of my interest in—in the control."

The door burst open and the topic of discussion came in. His surliness of the day before was gone and he pranced across the room and slapped Dick on the back.

"Ah, there, old inventor, how's the marvel of the age working this morning?"

"The control seems to work all right. I had her up," said Dick. "Nothing wrong, far as we could see. Can you take her up now? I'll catch you on the radiophone. Perkins will be here any minute and I'd like to know how you find it before he goes up."

Marian had slipped from the room while the two talked.

"Cheerio," Jack grinned, "I hope it'll clear my head. Had to stay up with a sick friend last night. Sorry I couldn't stay to help, but I had promised weeks ago to take in this affair."

"O, that's all right," said Dick a trifle wearily, but somewhat reassured by Jack's friendly manner, "Swanson helped some. I'll hook up the radio."

IN THE radio room Dick was soon joined by Captain Perkins and Manager Burton. Only Dick wondered where Marian had gone, and even he was soon too absorbed in the vitally important business at hand to remark her absence.

Down the field they heard the plane roar, a few minutes later, and watched from the windows as it took the air in a long easy climb. At the radio board Dick sat with the earphones on his head. "Hello," he called several times, but received no response. "Can you hear me, Jack?" likewise brought no answer. He worked feverishly with the battery connections and then tested every part of the receiver.

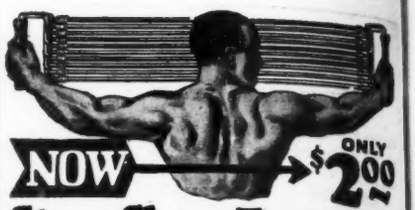
Suddenly the watchers saw him become rigid, his face ashy gray.

"What!" he called thickly. "What's that? —*Marian!* What are you doing up there? He collapsed? My God! . . . Is the automatic control working? You know how to push the buttons? Keep up to about five thousand. . . Circle over the field if you can. . . I'll come up and get you—some way."

He tore the phones from his head, as the others gazed blankly at him.

"She went up with Jack and he has dropped dead—or unconscious. I'll go up after her in my old Jenny. Captain Perkins, will you pilot her?"

Perkins nodded. (*Continued on page 127*)



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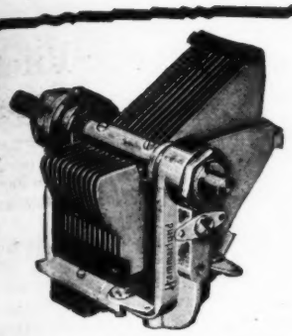

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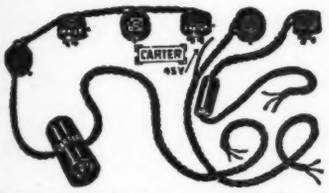

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The Electric Pilot

(*Continued from page 126*)

"But, Dick!" cried the manager. "What can you do? You can't get Jack out of the narrow cockpit and you can't operate the *Dragon Fly* unless you do!"

"Marian says the control is working. I guess it's up to me to pull some of my old tricks—if old Jenny can still do her stuff."

Burton paced up and down, then seized the radio transmitter. As Dick and Perkins rushed from the room they heard Burton talking to the girl in the clouds. "Keep on a level keel, Marian," they heard his choking voice. "Can you read the gas gage?" Dick refused to think what would happen if Jack had neglected to fill the tank.

While Dick strapped on his parachute the old biplane was wheeled out by white-faced mechanics. He tossed the coiled rope ladder on to the lower wing, tied it loosely with a length of rope, and sprang in beside Captain Perkins, who sat with tight lips and playing face muscles.

A FEW moments later the old ship roared across the field and rose swiftly. Climbing in a steep spiral, they made directly for the *Dragon Fly* circling far overhead.

"It's the acid test of the automatic," the captain shouted into Dick's ear. "I only hope this old boat can catch her!"

Dick nodded. "I'll drop the ladder when we swing over her cockpit. Here goes!" He crawled from his seat and cautiously picked his way to the lower wing, his knees shaking slightly in spite of himself. With nervous fingers he tied the ladder to one of the struts and his safety rope to another. Then he crouched, his back to the roaring wind, and waited.

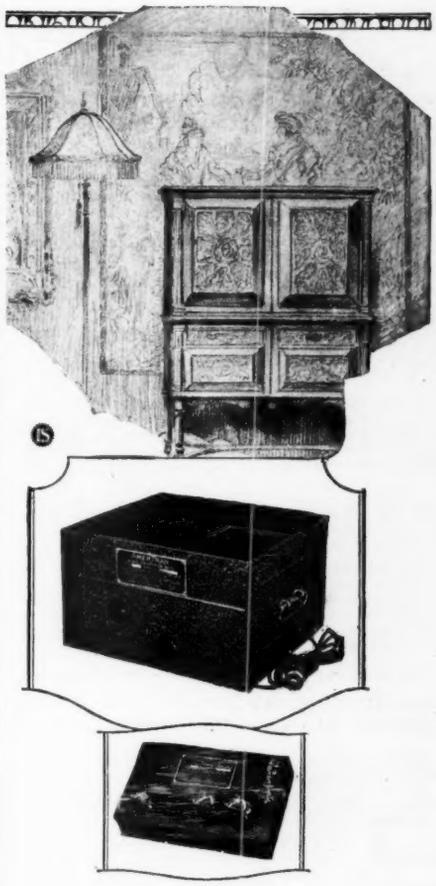
It seemed hours before they lessened the gap, overhauling the *Dragon Fly* just as it made another turn. Through Dick's head, over and over again, ran the refrain " . . . the pilot's drunk, the kid is sure to flop." Impatiently he shook the words away. Other thoughts took their place—Marian's life hanging in the balance—her brave fight for his own success—the pilot who had scoffed at him—both lives, perhaps all of them, dependent upon the faithful working of his invention—if it stopped for only a moment—or the gas gave out——.

The Jenny now hovered directly above the *Dragon Fly*, and Dick looked down into the tiny cockpit. Marian was lying half across the low partition that separated the rear seat from that of the pilot; Jack must be slumped on the floor. Marian half rose and waved at them, with a brave smile that brought a film to his eyes.

HE UNCOILED the rope and cast off the ladder, as the captain strained every ounce of speed from the faithful old motor and wings. As they swooped down, every danger which he had so lightly ignored in his stunting days seemed vastly magnified. "If we should strike an air pocket at the wrong moment!" he groaned to himself. "One foot too close, and we'll all crash. The captain is doing himself proud. It's up to the old stunter now!"

In the gale the end of the swaying ladder flapped close to the monoplane's cockpit. Dick drew a deep breath which was close to a sob and, grasping the rope, swung out on to the ladder. Rung by rung he descended into space, far slower than in the old days—no chances to take now—and from next to the lowest rung, dropped the rope-end toward the cockpit and the crumpled form he now could see lying there. Jack's head rested against the control board. As the two planes came within a few feet, Dick loosened his hold of the ladder with one hand, and reached down to fasten the rope to the parachute harness of the unconscious pilot.

Again and again he strained every ounce of his taut muscles, but he could not stretch far enough. He stepped (*Continued on page 128*)



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The Electric Pilot

(*Continued from page 127*)

to the bottom rung, but the planes separated. He glanced at Marian's white face, and touched her shoulder reassuringly before they were drawn apart again. Must try another tack—had to be done!

He climbed a couple of rungs, hooked his legs through, and lowered his body until he hung head downward as in his stunting days. His brain seemed to clear, as he swung like a pendulum and waited. It was the stunt that had thrilled thousands—but never had there been such a desperate need. He swore softly as he dangled there. At last, as he swung directly over the cockpit below, he grasped its edge with one hand and with the other rapidly passed the rope through the straps of Jack's parachute. Feverishly he tied it in a strong bowline knot—no slips now!

NOW he righted himself and signaled to Perkins. Guiding the rope as the Jenny rose, he eased the inert burden from the cockpit, and at last, with a final jerk, Jack's limp body dangled in the air. "All well so far," Dick breathed to himself.

But as he climbed his ladder rapidly, and was about to draw himself to the silver wing above, his thumb caught in the ring of his rip-cord. Instantly there was a sharp jerk at his shoulders—the pilot-'chute was free! In another moment the big parachute would be released—dragging him from his precarious hold. . .

Desperately he tore at the fastening straps with his free hand, flinging off the harness at the very instant that the great parachute billowed out in the wind behind him. He sighed with relief as he saw that it had dropped away without fouling either of the planes.

He climbed somewhat weakly onto the wing—slowly—carefully. Didn't dare to make a misstep now—too much at stake—why did this trick seem to take so much more time and breath than in the old days?

He rubbed and beat his hands, numbed and nerveless. Then hauling in the rope, hand over hand, he drew up the limp, swaying form until at last he had it over the edge and on to the wing. He lashed it securely to the struts, heaved a sigh of relief as he felt Jack's beating heart, and then crawled back to where Captain Perkins sat watching him closely.

"Plane change next!" he shouted into Perkins' ear. "Swing close up under her, and I'll catch the tip of the wing and climb up." A sudden pallor on the pilot's ruddy face startled him.

"Where is she?" Perkins yelled.

DICK gave one glance over the fuselage, the stiff wind striking his face a stinging blow. "To the left!" he shouted. "Circle over those clouds behind." Neither had noticed the fleecy billows which had come up from the west. They rose a few hundred feet, and for interminable minutes searched the horizon anxiously. Then, as suddenly as she had vanished, the *Dragon Fly* popped out of the clouds, shining with dampness. The little plane had turned completely around.

"The girl's got nerve," Dick read from the captain's lips, and he nodded vigorously as he scrambled out upon the top wing of the Jenny. If all went well, this stunt would be no harder than the last, but. . .

They swooped down below the little monoplane, and Perkins brought the two wings almost together. Too close, Dick realized, as he ducked flat just in time to escape the whirring propeller near his head. Perkins looked back at him with white face, and Marian's wide eyes gazed starkly at him from the edge of her cockpit. All three of them knew, he thought dimly, what a slip meant now, with no parachute on his back. It was the end for two of (*Continued on page 129*)

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The Electric Pilot

(Continued from page 128)

them if he did not make it, for the gas would not hold out forever—and there were no other stunt pilots on that gray field far below.

He signaled to Perkins to try it again. But this time the planes passed too far apart for him to reach the wing of the monoplane above. After two more attempts he gave it up and crawled back to the cockpit. Perkins looked at him appealingly.

"It's a tough stunt at best!" Dick called, leaning close. "I'll try the rope ladder again—try to drop on to the wing—never did it but got to this time."

Climbing back to the wing, somewhat wearily, he straddled the limp body at his feet, and uncoiled the ladder once more. Again they were over the *Dragon Fly.* He awaited his chance, and as the little wing glistened under his feet, he carefully swung down the ladder and stood swaying on the last rung—like "crack the whip" he thought, as he crouched down, grasped the bottom rung, and swung into the air, a trapeze performer under a blue canopy.

WITH calculating eye he waited until the exact center of the monoplane's wing came under his swaying feet, then let go his hold and dropped a couple of feet to the fragile fabric which stood between him and eternity. He grasped desperately at the edge of the wing as he fell upon his knees. Instantly, the tiny craft careened under the unaccustomed load so far forward and dipped her nose downward. Then a sudden up-current caught the tip of the wing, and clutch as he would, his body slowly slid around on the slippery linen.

He hugged the surface, and glimpsed Marian's frightened face as she leaned forward to press a button. The nose responded to the control, but not quickly enough. He felt himself slowly slipping off into space, helped by the pressure of the wind. Clutching desperately, he just managed to grasp the smooth rim of the cockpit with one hand. He felt a hand tighten upon the collar of his suit—and seizing the rim with his other hand, by a final supreme effort hoisted himself up and tumbled head foremost into the cockpit.

"O, Dick, thank God!" Marian reached forward, oblivious to the rushing air, to rub his numb arms. It was several minutes before he could use them again or could trust himself to speak.

"All safe now, Marian," he called at last. "The old automatic did its stuff this time!"

WITH expert hands he grasped the joy stick, signaling Perkins to go down. A swift, steep ride, and a few moments later they were following the dusty track of the old Jenny across the field. Taxi-ing over to the hangar, Dick noted dimly that the field seemed to be alive with waving hats and arms.

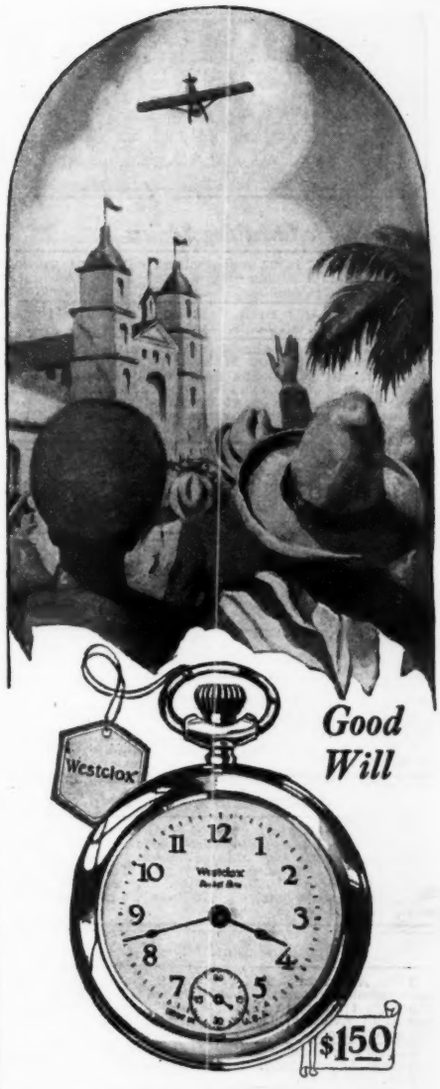
No one knows exactly what happened then. Jack swears he saw Marian strangling Dick when the latter lifted her from the tiny cockpit. Marian says Dick almost broke her back. Dick says his wife *will* have a broken back if she ever risks her neck to "check up" on another pilot.

All agree that Jack mixes no more moonshine and altitude. Also that Dick refused to let him resign. And when Dick handed him a worn penny with filed edges, which Marian had found in the cockpit, Jack confessed:

"*I'll* say it's a lucky penny. I slipped it between the leaves of the switch, to keep the juice from the control. But if it hadn't dropped out, when my head struck the board, Marian would now be a blond angel . . ."

"And you'd be piloting the Devil's Airline Ferry," finished Dick.

Manager Burton never will know what "gummed up" those tests of the automatic control.



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Gives 42 Quarts of Blood to Save 86 Lives

(Continued from page 34)

could chew pig iron, his stomach could digest it!

By the merest chance Kane started on his unusual career. One spring morning in 1914, a sailor without a ship, he saw in a newspaper a hospital's advertisement, "Blood Donors Wanted." He went and with twenty others was "typed up." Next morning at two o'clock he was roused from sleep by a messenger with a telegram ordering him to report at once for a transfusion. Kane went, and saved a young girl, critically anemic.

Doctors who saw his blood specimen soon by their calls forced Kane to choose those he would answer. Then he decided to "specialize" for the benefit of women and children. Repeatedly he has volunteered his blood free to some poor patient, though professional blood donors ordinarily get from forty to a hundred dollars a quart. "I feel that it's my duty," he told me.

Once a man was stricken with a disease so contagious that he was isolated on an island in Long Island Sound, N. Y. Doctors warned Kane to take an immunizing serum, but he declined, gave the sick man a full quart of his blood, and returned to his work, none the worse.

THANKS to modern surgical methods, transfusions no longer are painful to donor or patient, Kane told me. It was a different story when he commenced his career. He showed me arms covered with knotted scars. The old method was to cut open the arm and dissect the vein, in order to remove blood; then to sew up the vein and dress the arm. Of the three methods in common use today, the latest is that developed by the noted New York pathologist, Dr. Lester J. Unger. Patient and donor lie side by side and blood flows directly between them through a rubber tube with vein-puncturing needles at either end. At the tube's middle, a delicate gage meters the blood and tells when the patient has had enough. Kane was one of the first to help Dr. Unger try out his new method.

Often the "Lindemann" method is used. The veins of the patient and the donor are punctured and small glass tubes are filled from one puncture and emptied into the other. If the patient is too ill to be moved, the blood is transferred to a vessel above his bed, and flows into his body by gravity through a tube and needle.

ALL classes of men are giving their blood to help sufferers. Some are friends and relatives of the injured, or ill, others are students, helping pay tuition. There are ne'er-do-wells, brightening their checkered careers with their first brave contributions to society—pints and quarts of their lifeblood; and there are modestly well-to-do men who need money for luxuries. Many policemen, such as William F. Parks, motorcycle officer of Brooklyn, N. Y., are generous donors; he has stepped upon the operating table twenty times, the last time to save the life of his own nineteen-month-old son.

Not long ago a man who had shot and seriously wounded a friend in the heat of a violent but foolish quarrel gave his blood to make what amends he could, and the transfusion averted the tragedy of death.

But Kane stands unique—the greatest of them all. Forty-two quarts of red fluid mark him as a man who has capitalized to the utmost his splendid physique and the amazing powers Nature has given—not for himself, but for humanity.

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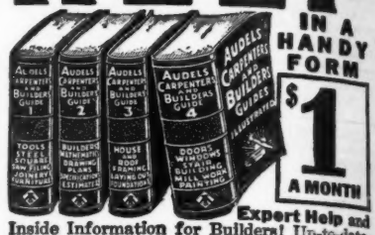

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Vile Smells Made into Perfumes

(Continued from page 30)

Caustic soda, potassium dichromate, extract of camphor, sulphuric acid—these rather unlovely substances carry no suggestion of sweet essences; yet the chemist of today produces from them the delicate fragrance of heliotrope.

Have you ever noticed how certain plants that have a decided odor in the daytime lose it after dark—for example, night-scented stock? And many solutions of odorous compounds undergo changes at night, taking on a colloidal, or viscous, character. This suggests that light has something to do with odor.

TAKING account of these peculiarities, a new theory of odors is that they are produced by electronic waves, instead of by fine particles that pass from the odorous substance and react on the nerves in our noses. These waves appear to be many hundred times shorter and many hundred times more frequent than the waves that give us the sensation of light. They are thought to have some relation to the waves of radiant heat.

Our language has no very definite words with which to describe and identify odors. This has caused scientists to propose sets of terms that would make the various scents readily identifiable. Dr. Septimus Piesse, an Englishman, suggests a scale of odors corresponding to the musical scale, to be known as the "odophone." Heavy odors, such as vanilla, are to be placed at the lower end of the scale, and sharp ones like peppermint at the upper end. For each note of the musical scale there is to be a corresponding classification of odor. A harmonious blend would then correspond to a chord.

Psychologists have repeatedly attempted to arrive at a scientific grouping of the odors. One proposed arrangement lists six elementary kinds—the spicy, the flowery, the fruity, the resinous, the foul, and the scorched.

IN THE production of perfumes from flowers, the industry makes use of a principle known to everyone who has ever found butter tainted with a taste of other food in the refrigerator. The perfumer saturates his flowers with fat. The result is pomade. The essence left by the flowers may be recovered by treating the pomade with alcohol. To get the essence direct, the flowers may be treated with steam, which when vaporized contains the essential oil, or fragrance.

Nature makes use of artful tricks in perfuming herself. Along with the separate sweet essences that go into the fragrance of a flower, she puts in impurities. Strange to say, these impurities apparently make the perfume of the flower all the sweeter, for the synthetic chemist can make and mix from his own sources all the pure elements, only to get a product that is just a little less exquisite than Nature's own.

But, says Prof. Marston T. Bogert, of Columbia University, one of the foremost authorities on the chemistry of perfumes, these impurities in time spoil the fragrance. The synthetic chemist's product doesn't spoil, and its variety is greater than Nature's.

At present the perfumery chemist is chiefly concerned with the problems of molecular composition of the various scent-producing substances. It was the discovery of the relation between molecular structure and colors that enabled the chemist to produce dyes of every hue in the rainbow—and more. Likewise, the discovery of kindred relations between drugs and the human organism gave us the products of modern pharmacy. Recalling the advances made possible by these discoveries, Prof. Bogert says that when similar discoveries have been made as to the nature of odors, we may expect to see the synthesis of every odor.

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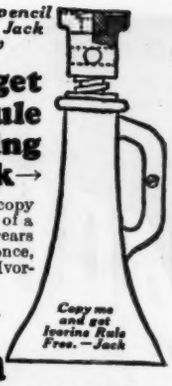

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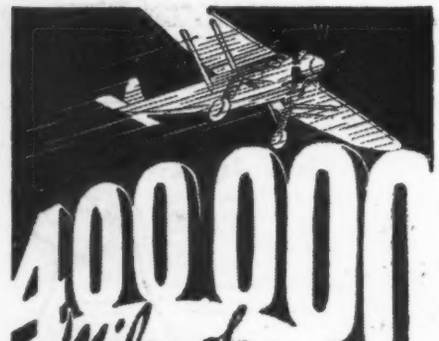

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Young America *Finds Its* Wings

(*Continued from page 29*)

machine when I was a boy. Since that time many marvelous things have happened in the field of aviation. The conquest of the air is a romantic story; many thrilling chapters are still to be written. The boys and girls of today are to have an important part in the aviation development of tomorrow. Building and flying model aircraft is not only a fascinating sport, but will be the means of helping to understand and appreciate what is to become an important feature of our lives."

A SECOND national contest is being staged by the Airplane Model League of America, with the sanction of the National Aeronautics Association. This tournament is headed by Commander Byrd and by William B. Stout, head of the Stout Metal Airplane Company, and a pioneer in building model planes. Two winners from each local contest will compete in a national tournament in Detroit June 29 and 30. And two national winners will be sent to Europe to compete with boys in London, Paris and Geneva for the world championship.

In a number of cities, park and playground commissioners have provided special facilities and equipment to aid the young aviators in flying their creations. In Los Angeles, the city Playground Commission has laid out a complete model airport, with landing fields, marked runways, and even miniature hangars. In addition, there are machine and carpentry shops, where boys can build their models under the guidance of expert instructors.

An important phase of the national tournaments, emphasized by Commander Byrd, is the accurate technical information, prepared by expert flyers and designers, which is supplied to contestants.

"The success of commercial aviation tomorrow lies with these youngsters of today," says Commander Byrd. "From among them will come our successful designers, manufacturers, promoters and flyers."

THE soundness of his prediction is borne out by history, in the tremendous part which boys and their toys have played in making flying the success it is today. Many of the leading designers and manufacturers of planes began their careers with flying models. For example, there is "Bill" Stout, designer of the famous all-metal monoplane which bears his name, and head of the great Ford airplane factories. It was away back in 1894 that Stout, a boy of fourteen, first began experimenting with a toy flying machine which he made with corks and feathers. Nearly twenty years ago, under the newspaper name of "Jack Knife," he was telling boys of Minneapolis how to build model airplanes, and staging model aviation contests. Shortly afterward he organized a group of Chicago boys into the Illinois Model Aero Club, probably the first of its kind in the world. Beginning in 1913, these boys engaged in model competition year after year, steadily gaining in skill. From the technical knowledge and experience they gained, more than one of them built a successful career in aviation. For example, there was George "Buck" Weaver, who became the maker of Waco planes. What he learned from flying models first won him a position with a large eastern airplane manufacturer. Within a few months he rose to be foreman of the company's most important construction department. Later he formed his own company and manufactured planes of his own design.

Emil E. Laird, later designer of the Laird plane, built his first model in 1913. A year later he set a world's duration record with an eighteen-inch model. (*Continued on page 137*)

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Young America *Finds Its* Wings

(*Continued from page 136*)

And in 1915 he built a full-sized, twelve-horsepower tractor biplane and flew it successfully! Ellis Cook, Lindsay Hittle and Harry Wells were other boys of the same club who obtained positions as experts with leading aircraft manufacturing companies.

Will the opportunities be as large for the boys and girls who are flying models now?

The answer of foremost American flyers and aviation engineers is a unanimous "Yes!"

Who are the boys who will find ways to make airplanes as safe and foolproof as the automobile is now? What about planes which will automatically adjust themselves to every air current; planes which will refuse to go down when the motor fails?

And what about gliders—planes that will fly without motors at all? The possibilities in this field have barely been touched.

EVEN now the American Motorless Aviation Club, recently organized in New York City, has launched a movement to encourage motorless gliding among schoolboys and young men. The plan is to form motorless aviation clubs similar to those in Germany, where gliding has become a popular sport. It is less dangerous and far less expensive, we are told, than flying motored planes.

For the thousands of American youths who are mastering aviation the opportunities are endless. That boy you see today launching his tiny plane may be king of the air tomorrow.

To Deliver Music by Wire

(*Continued from page 21*)

The main New York sending station will include forty studios ranging from large concert halls to small lecture rooms.

Chief among the advantages claimed for wired radio are these:

Because the signals are confined to wires, reception will be free from static, conflicting broadcasting stations, noises from electrical machinery and other interference in the ether; less energy will be wasted, the signals traveling greater distances with greater power.

The great power will eliminate the need of radio-frequency amplifiers ordinarily required to bring in weak signals from the ether. This will mean fewer tubes and consequently less distortion within the receiver itself. Pure tone quality will be further assured, it is asserted, because the set is designed to receive wave bands of precisely the right breadth to reproduce the delicate overtones which make music or voice sound natural.

AT PRESENT it is not uncommon to hear the same number repeated several times in one evening, by the same or different stations. Since the planning of wired radio programs will be under control of one station management, such duplication can be avoided.

If the subscriber desires, a motor-driven phonograph attachment will be supplied with the receiver, with pick-up device for reproducing any record through the loudspeaker. Eventually, it is expected, wired radio vision will be added to the service.

At present 18,600,000 homes in the United States are wired for electricity. Within the next five years, it is estimated, 3,150,000 of these homes will have wired radio.

Sponsors of the vast project believe it will result in more efficient utilization of radio science.

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WHETHER the captain's daughter expected to be marooned on a desert island for the rest of her life and wished to make sure of a good companion, or whether she valued good entertainment above all other treasures, the letter does not say. Certainly she expected some dull hours after the excitement of a shipwreck and used good judgment in selecting a lively, cheery and stimulating companion.

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Here Are Correct Answers to Questions on Page 63

1. The largest tree, although not the tallest one, yet discovered by botanists is a cypress tree living in the Mexican village of Tula, about eighty miles east of the town of Oaxaca. This famous tree has a trunk 154 feet in circumference and is supposed to be hundreds of years old, possibly even a thousand or two.

2. The delightful old city of Guadalajara, west of Mexico City. Even in the times immediately following the Spanish conquest, Guadalajara was a point of settlement for the Spanish nobility. The descendants of the Spanish grandees of early times retain the beauty and charm of their Castilian women ancestors.

3. The present supply of the world comes mainly from the island of Jamaica, although the mahogany tree grows in most of the islands of the West Indies, in the countries of Central America, and in certain parts of India and Africa.

4. The island of Jamaica, just south of Cuba.

5. The expression "black diamonds" sometimes is applied to coal, but this is merely a metaphor. There really are black diamonds, however, real diamonds that are full and opaque instead of being brilliant and transparent. These black diamonds are called "bort" and are used to make drilling and cutting tools. Quantities of them are found in the gravel of Brazil, whence they are exported.

6. This is one of the customs of the city of Riga, capital of the small republic of Latvia.

7. There seems little doubt that it is the famous town of St. Augustine, on the east coast of Florida, founded by the Spaniards in 1565.

8. Most of the polar explorers have carried their food with them in concentrated form. Some years ago the explorer, Vilhjalmur Stefansson, proved that it was possible to live for long periods on the meat of Arctic animals, such as seals and polar bears, with small shrimp found in profusion in polar seas.

9. Crater Lake, in southwestern Oregon, occupies what was once the crater of a volcano. It is approximately five miles in diameter and is more than 2000 feet deep. No streams flow into it. So far as known, it has no outlet. It is filled by rain water. Evaporation keeps the crater from filling.

10. There are at least eight varieties of this famous fly. Among them they cover practically all of the tropical part of Africa, including the southern Sudan, the Belgian Congo and parts of the British colonies on the east coast. The fly is one of the most serious insect enemies of man.

11. When Australia was discovered by the whites, there were no animals of the rabbit tribe on the continent. Early settlers brought a few rabbits from Europe. Some of these escaped, multiplied rapidly, and became a great agricultural pest. The Australians have not yet been able to prevent entirely the depredations of these animals.

12. It is natural for us to think that the religion of Palestine is mainly Jewish, but this is not true. According to the latest figures, approximately seventy-seven percent of the population of Palestine is Mohammedan. Nearly twelve percent are Christians. Less than eleven percent are Jews.

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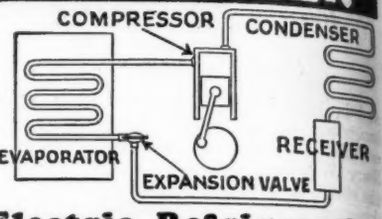

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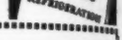

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He Built a Home in Odd Time

(*Continued from page 70*)

this lining was just placed in the form before pouring the concrete. It is held fast."

"How did you estimate the size of the heating plant?"

"The neighbors and I figured it out roughly. We have a hot water system with a 600-foot boiler and 302 feet of radiators. Hot water costs more than steam but to me it is worth all the difference. The heat is uniform, the house is always comfortable, and the system is noiseless. I bought and installed the plant piecemeal, first getting the boiler with a few lengths of pipe and fittings, and learned how to hook them up as I went along. The total cost was over $500."

"Before advising other people to follow your example and build a house in their spare time," I suggested, "you might tell me how long this whole job took."

"Certainly," replied Elliott. "We began in March and moved in some time in October. And it cost us just $6,500. But don't forget you need a set of obliging neighbors. Without their aid I might still be sawing and pounding all over the lot."

Solving the Mystery of the Shape of the Earth

(*Continued from page 51*)

It was in St. Louis, in 1819, that Captain John Cleves Symmes issued the first details of what has come to be known as The Symmes Theory of Concentric Spheres (Drawing No. 14). In 1822 and again in 1824 he petitioned the Congress of the United States, asking for two vessels whereby to enter, if he might, the interior of the earth.

ACCORDING to Symmes' theory, the earth, and all stars, consist of a collection of spheres, more or less solid, concentric with each other, and more or less open at their poles; each sphere separated from its neighbors by space rich in aerial elastic fluid. The planet called earth is composed of at least five concentric spheres, all habitable as well upon the concave as the convex surface. The north polar opening would be about 4,000 miles in diameter, the southern 6,000.

Little less than a century later, Marshall Gardner, at Aurora, Illinois, in 1913, published *A Journey to the Earth's Interior,* giving his theory of a hollow earth, open at the poles, with, however, but one shell 800 miles thick, and with an interior sun (Drawing No. 15). He gives this single shell a "center of gravity" that allows for a concave surface probably the reverse of the outer as regards the distribution of land and water. The polar openings are estimated as 1,400 miles in diameter, which allows the imagined voyager sufficient "curve" for rounding the great capes of water, or "the lips of the world."

OF THE earth as a triangular pyramid (Drawing No. 16) Moreux, in his *Astronomy To-day,* points out that the facts seem to be in considerable agreement with this supposition. . . . "The tetrahedral theory accounts for the inequalities of the polar radii, and at the same time gives a more satisfactory explanation than any rival theory does of certain facts of astronomy which are inconsistent with the earth's being a true ellipsoid of revolution."

What is the earth? A geoid, says science. What is a geoid? An earth-shaped body. What is an earth-shaped body? A geoid.

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Aviation Slang

(Continued from page 72)

landing both wheels and the tail skid touch the ground simultaneously. In a "tail-high" or "fast" landing the wheels touch first; in a "tail-low" or "slow" landing the tail skid touches first.

A "Chinese three-point landing" is a crash landing, the three points in this case being the propeller hub, one wheel and one wing-tip; this is also called "nosing-up" or "nosing-over." A "pancake landing" occurs when the ship is leveled off several feet above the ground and allowed to fall in from that height. "Ballooning in" or a "parachute approach" means a slow approach with a little power; the nose is held up and the ship settles slowly to the ground.

The throttle is called the "gun." The "mixture control" or "altitude adjustment" corresponds to the choke in an automobile; it is used to obtain a smooth lean mixture at normal levels and to compensate for the rarer air at high altitudes. A pilot's "sense of feel" is measured by his ability to fly well without instruments.

To be "rough on the controls" is to throw a ship around with unnecessary violence. "Avigation" is a recently coined air word corresponding to navigation for ships. To "bounce" or "porpoise" is to leave the ground or water on landing.

The "flippers" or vertical (up and down) controls of a plane derive their name from their similarity in location, function and appearance to the flukes or flippers of a whale.

A "chandelle" is a French term in general use denoting a steep climbing turn. A stupid pilot is said to be "in a flat spin in a fog." "Fair weather pilots" fly only in good flying weather; bad flying weather is called "bird-walking weather."

"STUNTING," "kicking them around," "acrobatics," or more correctly "aerobatics," all mean the same thing—maneuvers known as "tail-spins," "wing-overs," "half-rolls," "loops," "rolls," "falling leafs," "reversements" and "Immelmanns." "Wing-overs," "half-rolls," "split-S turns" and "reversements" are practically the same thing, varying only slightly; they all result in a sharp 180-degree change or reversal of the course. In an "Immelmann" the plane is half-looped onto its back, then twisted through a half-roll to an upright position in normal flight. "Rolls" or "half-rolls" may be done level, off the back as on the top of a loop, or with the ship pulled up vertically.

"Rolls" are sometimes called "barrel-rolls." In rolling the controls are handled so that the wings revolve rapidly one or more complete turns around the axis of the fuselage (one turn, single roll; two turns, double roll). In a "falling leaf" the plane starts to spin, but is caught with the controls and swung back almost to a spin in the opposite direction, when it is caught again, and so on; as a result the ship twinkles downward from side to side like a dead leaf. A "flipper turn" is made with the ship on its side (more than forty-five degrees of bank) and is so called because the flippers instead of the rudder are used to keep it turning.

These phrases should enable one to keep abreast of the conversation when a couple of birdmen are doing some verbal aerobatics. If they bore you simply tell them to "put those crates in the hangar."

How Birds Began Migrating

BIRD migrations have been only half explained. But now Herbert Janvrin Browne, consulting meteorologist of Washington, D. C., says the birds' habit began far back in the Ice Age. The northern and southern ends of the earth were covered with ice. In the winters the ice caps advanced and naturally the birds moved.

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Cars Our Readers Choose

(*Continued from page 47*)

will be leading the life of a pack of gypsies instead of developing a decent home life.

"'Finally, I'm sick and tired of riding on the back seat of my Bill's car.'"

Gus joined in the gale of laughter provoked by this letter. "That," he said "is a warning to show you what will happen if you get too nutty over automobiles. Now here's a letter with a totally different idea," he continued as he picked up the next one.

"'I would like to make a suggestion, in regard to that new car you are thinking of buying.' (This is from Lucile Boone, of Mantua, Ohio.) 'I suggest that you buy two of the new Fords, a roadster and a two-door sedan, in place of one larger and more expensive car. The roadster can be used in fine weather and the sedan will be handy for bad weather and winter. You say Mrs. Crowley is going to drive, which means there will be times when you each want a car. When that happens you can let her take the sedan and you can take the roadster. Thus each of you will have the use of a car, whereas with one expensive car, either you or your wife would have to go without. Then, too, if one car is temporarily out of commission the other will be available so you won't get stuck without any car.'"

"I NEVER looked at it that way," observed Crowley. "Do you think much of the idea, Gus?"

"That depends on several things," Gus stated. "If you haven't a two-car garage you'll have to pay out extra money for storage. If you don't use the car for business you aren't likely to want it during the daytime when your wife needs it. Of course, if you have room to store two cars without extra expense and you need a car for business use, two cars will be of more use than one.

"The next letter, I see, is from John P. Picco, Salt Lake City, Utah, an owner of a light six. He writes:

"'This is my third Essex coach and it is better than the other two, which is going some. I have over a dozen friends who have bought Essexes on my recommendation and to date not one of them is anything but pleased with the purchase.

"I am an Essex enthusiast because every one of my Essex cars has shown less than seven cents a mile for operating cost, which includes every cent I have spent on operating, insurance, depreciation, interest on money invested, garage rent and so on. I can go fifty-five miles an hour all day long and feel rested at the end of the day.'

"AND here's an old timer, Jesse J. Rogers, of Miami, Florida," said Gus, proceeding to the next letter:

"'Dear Gus: I think your friend Crowley has made a mistake in waiting until he could spend as much as $2,000 for a car. It has made him more or less a cynic. Now if he had started in the automobile game about the time I did he would probably have had $360 available and there would have been no question as to what car to buy! In another way he has missed the spirit of adventure that belonged to automobiling as practiced ten years ago. Roads are so good now that it has lost all the thrills. Crossing Georgia or the Carolinas now is but a matter of a few hours' driving, while ten years ago it was a real adventure.

"'I suggest he buy a Willys Knight Model 70, painted in two shades of gray, and black above the window sills. This will give him a rich but not gaudy car that, because it has no valves to grind, will give him simplicity in operation, low upkeep cost and ample power without noise.'

"He is quite right about the roads being better," commented Gus, "but any one who gets any thrills out of

(*Continued on page 145*)

Cars Our Readers Choose

(*Continued from page 142*)

rotten roads can find plenty to practice on!

"Here are a couple of letters that don't hold out much hope for you, Bill, as an auto driver:

"'In the first place,' writes Rube W. Davison, of Holderness, New Hampshire, 'I wouldn't spend $2,000 on a car. Half that amount leaves something for doctors' bills or general repairs should Bill climb a tree while learning. A Pontiac coach would be my choice, as Mrs. Bill could easily handle it, and when the whole family is learning to drive there isn't much left of a poor car at the end of a year—so why spend so much on something you are going to spoil?'"

Then Gus read a letter from John G. Hanna, of Dunedin, Fla.

"'I ADVISE Bill Crowley to buy a Dodge Victory Six sedan. The six-cylinder engine is the most satisfactory and the sedan is the family model. The car is large enough for comfort, but not so bulky and heavy as to increase the difficulties of a man learning to handle his first car. The price is far below Crowley's limit, as it should be, because a man's first car is bound to involve more service and repair expense, more rapid wear and depreciation, and earlier trade-in than will be expected after he becomes a skilled driver. The staunch steel body is an item the inexperienced driver cannot afford to overlook.'

"And now here's a letter from a man who has been driving cars for twenty-five years, R. C. Jennings, of Denver, Colorado," said Gus.

"'I drove my first car, a steamer, in 1903,' he writes, 'and I haven't missed many days since. I have owned forty-five different cars—a great number of them haven't any surviving relatives at the present time. There have been the most wonderful changes the past twenty years, so that today it doesn't make much difference what car you buy, merely how much you want to spend, as all cars will return dollar for dollar if given the proper treatment. I find that cars in the $1,500 class give the best returns for the average family. I would advise Bill to buy a five-passenger Buick sedan, give it proper care, and receive in return service and satisfaction.'

"This is the last one, from Wallace Bryson, of Cedar Rapids, Iowa," said Gus.

"'Concerning what make and model car Bill Crowley should purchase, it is my best judgment that he select the Auburn 8-77, five-passenger sedan, for the following reasons:

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"There you are," said Gus, as he shuffled the letters into a pile and handed them to Bill Crowley. "I'd advise you to read them all over again very carefully and make a list of the various reasons for buying."

"In other words," Bill said, "you're not telling me what car to buy. You're letting me in on the secret of why other people buy cars so I will have something to go on when I pick out my own."

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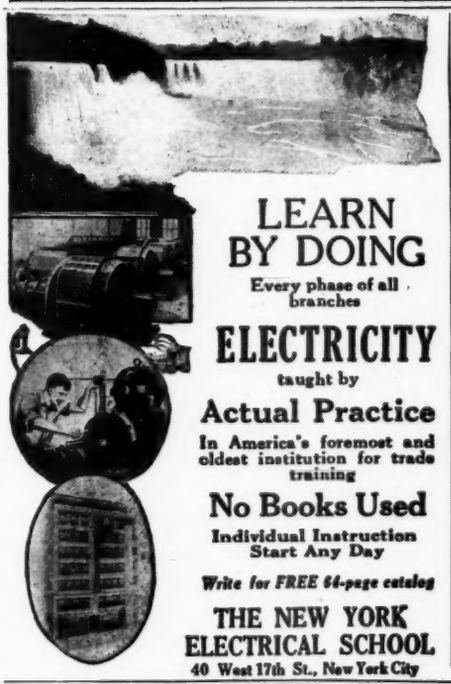

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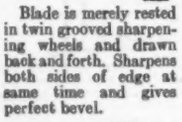

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The Movie Maker

(*Continued from page 44*)

carefully cut and spliced, inserting occasional new strips where the damage had been irreparable.

But as night after night had passed, and he had fallen asleep only to fight nightmare flames—to swing from roof to roof carrying sometimes the professor, sometimes the unwieldy drying rack—he had begun to realize that he was getting perilously near the breaking point. He had seen it happen with other directors and he knew why they occasionally celebrated the completion of a big picture with a stay in a sanitarium.

But it was not alone the driving necessity of finishing the picture that drew his nerves taut. It was the heavy weight of all that depended on its success—the moral and financial obligation he felt toward every member of the little group that worked with him so hard and so faithfully. Each was gambling more on the venture than he could afford to lose, and Donald Kennedy was the keystone of the arch. If he fell, the entire structure would collapse. If he and his machine had been swallowed up in that fire. . . .

AS IN his tortured dreams Judy always appeared to him a symbol of safety, so the idea began to obsess him in waking moments. Again and again he considered the idea of making her his heir. Only the absurd formality of legally willing to her his nebulous estate made him hesitate. Tonight, for the third time, after concentrating on cost figures, his mind had gone AWOL, and he had wakened from his trance to find that he had been scrawling a homemade will, empowering Judy to discharge all just debts and claims and making her sole beneficiary of the remainder of his estate.

The stars were growing dim when Don finally turned homeward, but he felt at last the comfortable sense of drowsiness and relaxation that had been denied him ten days. Absurd or not, he had decided to go to a lawyer the next morning.

Walking across the lot to the stage shed that housed the professor's workshop, Don overtook Jerry headed in the same direction, and asked if he had called at the express office to inquire about Bozo's missing reels.

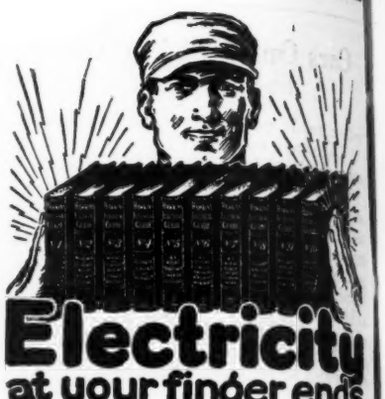
"I've stopped there every morning for the last few days," Jerry answered, "but they have nothing for us. Why don't you send a camera man to the Mohave Desert for some backgrounds instead of waiting for Bozo's? A desert is a desert in any part of the world."

"RIGHT you are," agreed Don, "but Bozo was to get some real oasis scenes that would be a nuisance and expense to build here; also some caravan and camel bits and a few long shots of Arab tribesmen that would add a lot of local color to the film and wouldn't cost a cent. It wouldn't be so cheap to hire a lot of camels and extras for those scenes even if we shot them here on the lot. If Bozo sends the Arabian backgrounds we can finish the scenes with just a few shots of the principals taken against the blank backgrounds, and get all the effect of a troop of actors transported to Arabia."

Jerry looked at the young director with real admiration.

"You know your stuff, boy," he declared. "So Bozo's side trip not only provides genuine backgrounds, but saves the salaries of a hundred or more extras—including camels! It took a long head to figure that out so far in advance."

"Save your compliments for Bozo," Don suggested. "The idea was his entirely. I didn't think the Arabian trip necessary, but he was determined to shoot the identical scenery Carleton used for the (*Continued on page 145*)



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The Movie Maker

(Continued from page 144)

'English Slave'—and shoot it better. Even offered to stand his own expenses for that part of the trip to pay off his grudge against Carleton by getting more beautiful photographic effects."

Jerry grinned his appreciation, and they stepped into the professor's workshop. A dozen or more artisans—scene painters and builders and expert model makers—were busy in the vast shed. At the far end, the professor's silvery head was a moving spot of light as he went from group to group, measuring, advising, and comparing details of models and sets with the portfolio of sketches and photographs he carried. Often he would hold a large reducing glass before him and squint with one earnest eye at some particular combination. Only in this way could he approximate the single vision effect of a group of objects seen through the camera lens.

BUT Don's gaze went directly to a large, low table over which stooped a trim figure in the inevitable khaki riding suit and red bandanna which was Judy's studio uniform. Instead of rushing to her with a cheerful greeting, as he would have done in the days before the fire, his newborn self-consciousness sent him the long way round. Giving her merely a casual nod, he walked the length of the shed toward the professor.

"The large boat sets will be ready for shooting tomorrow," the old man reported, "and here is the miniature scene."

On a table near by was a small tank bordered with a replica of the Genoan seacoast pictured on one of Bozo's reels. In the tank itself several tiny, richly ornamented sailing vessels of medieval design floated at anchor, ready to be set in controlled motion by electric wires under the water. Professor Mahrlenburg called their attention to additional miniature back drops and borders piled on a bench beside the table. Resting there also were two sea craft of somewhat similar design, but flying small skull-and-crossbone flags.

"The Barbary pirate ships," he explained to curious Jerry. "When we have all the footage for the sequence where the crusaders set sail from Genoa, we remove that scenery from around the tank and substitute these cloud and horizon back drops to show their ships are in the middle of the Mediterranean when the pirates attack."

"AND this is part of the African shore to be used for the shipwreck scene," added Don, picking up an irregularly curved section of papier-mâché, over which was glued a thin layer of sand. A few tiny palm trees fringed its farther side.

"Yes, but when we set it up we pour on more sand."

Jerry, holding a pirate ship, was admiring its finely carved figurehead.

"This is a beauty, professor!" he exclaimed. "Gosh, wasn't it lucky you brought all your models here before the fire!"

"It is most important not to hurry the model makers," remarked the old man. "They finished these ships a month ago. Now they are working on the prehistoric animals. See—on that low table near Judy we will build the battlefield."

The three strolled down the shed and came upon Judy seated on a low stool by the table. Spread out before her were several queer looking animal models in various stages of completion. She was listening attentively to one of the model makers, an old Swiss wood carver, as he explained the mechanism of a two-foot dinosaur.

"Look!" she exclaimed, holding up the strange creature. "Hans says the body is made of an ordinary rubber bath sponge, with a balloon for lungs." (Continued on page 148)

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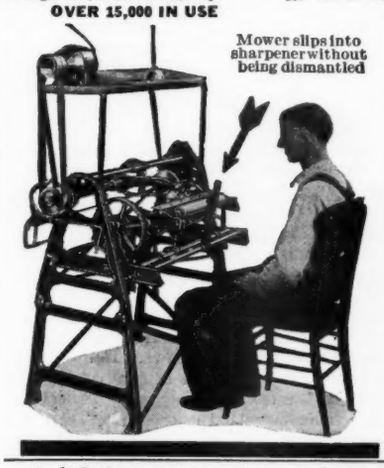

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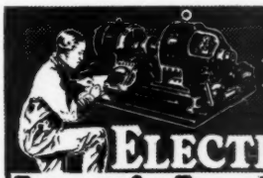

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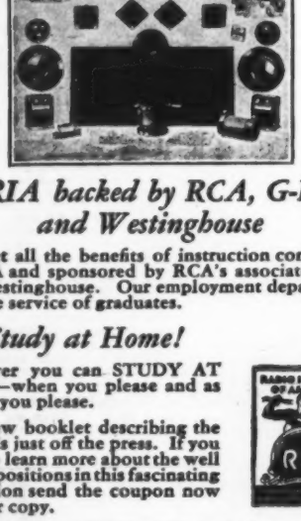

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The Movie Maker

(*Continued from page 145*)

She pressed the chest of the dinosaur between thumb and forefinger, and released it. The upper part of the beast's body expanded with the intake of air.

While the three young people poked and fingered the grotesque reminders of a lost world, the professor beamingly explained that he had made the original models twenty years before, when doing scientific research work in the British Museum. The skeletons he had carved from wood, making them exact replicas of the gigantic fossilized and restored bones of the livestock of a prehistoric age.

"The dinosaur, from tip of tail to snout, was nearly as long as this shed," he told them. "In the Museum they had to carry his tail around a curve in the hall and part way into another room."

THE other animals—the brontosaurus, the pterodactyl, and their hideous brothers—he was building in exactly comparative size, using the same mechanical construction—skeletons carved from strong, light wood, joints articulated with rubber bands, hides of imitation lizard leather. Their mouths were soft, stretchable modeling clay; their eyes, made by an expert taxidermist and operated by tiny wires, could blink and roll alarmingly; and out of their spongy rubber bodies would ooze thick molasses blood when wounded in battle.

Old Hans smiled toothlessly as Professor Mahrlenburg added this gruesome detail, and gathering up his pets, he carried them to the workbench near the windows. Judy handed the professor a scenic plan of the battlefield to be built on the table.

"This checks with the scenario," she said. Then, whirling over several pages of the long thick manuscript in her hand, she turned to Don. "We're up to schedule," she remarked. "But hadn't we better go out on location now for the snow scenes, so we can afford to wait a little longer for Bozo's reels?"

"Say, everybody, I've got an idea!" interrupted Jerry explosively. "Let's take those scenes in Montana. They're having zero weather and heavy snowfall there. The Neelys have invited Judy and me up for Christmas. We'll just wire them to advance their invitation a month and expand it to include several more of us."

"But think of the time and expense involved," explained Don. "Northern California will do."

"IT'LL take only a few days more to go to Montana. And as for the expense, it's my idea the Neelys will be so glad to have us break the monotony that they'll insist on our being their guests. They've got an enormous place, and they get pretty lonely once the snow starts. It's an ideal location. A small lake, horses that can't be beat, and plenty of ranch hands with time hanging heavy on their hands. We can use them as scene shifters and extras."

Don hesitated. If the Neelys should want them as guests, their only expense would be railroad fare—a small item compared with the food and lodging account on location. Unconsciously he sighed and Jerry was quick to follow up his advantage.

"Anybody can see you're completely fagged—and have you noticed how tired Margaret is looking?" he asked. "The Montana jaunt would be a tonic. We can't let anything happen to her."

"I should say not!" agreed Don heartily. "The trip might do her good." He glanced at Judy. A moment before her face had been eager with anticipation; he was surprised now to notice that it was clouded. Slightly puzzled, he turned to Jerry. "See if you can fix it up," he said. "If we're going we must start early next week."

(*Continued on page 147*)

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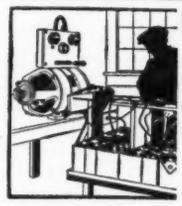

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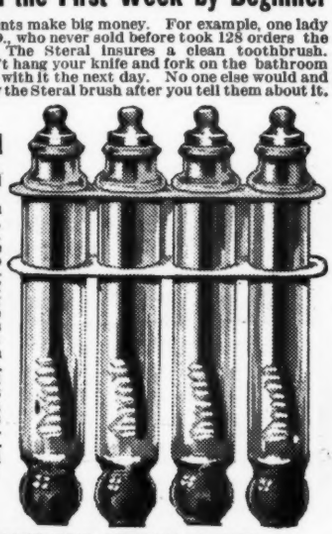

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A definite program for getting ahead financially will be found on page four of this issue.

The Movie Maker

(Continued from page 146)

He lingered a moment to talk with the professor, while the other two strolled on. Before he left the studio shed he had confirmed his suspicions that Margaret's troubled look was due to financial worry. Living at his daughter's home since the fire, Professor Mahrlenburg had learned that the beautiful house in Beverly Hills, with its luxurious contents, was mortgaged to the roof. Though Don knew that Margaret had sold her expensive roadster and dismissed not only her chauffeur but all her servants except an old couple, he was only now aware that she was bordering so close on a financial crash. He would make it his business, on the Montana trip, to find out the exact state of her affairs.

THE Neely place, where Jerry had acquired his skilled horsemanship years before, was a large "dude ranch" where annual rodeos were held. During the summer months it was crowded with eastern visitors, would-be cowboys. In the winter, however, it was almost deserted, except for the owners and a score or more servants and ranch hands.

Upon receipt of the Neelys' cordial return wire, placing the ranch and all its facilities at Jerry's disposal, the props were immediately expressed to Montana—a number of medieval costumes, weapons, gayly ornamented driving reins, and two large sledlike vehicles, more sledges than sleighs. Actors and technical people were to follow a few days later. Adopting Jerry's suggestion of using the ranch people for extras and stage hands, Don selected only a small group to take to Montana. Only two camera men, with their assistants and a general utility man, were needed besides Jerry, Margaret and Judy.

* * *

In the interval before the start of the trip, Don bent his efforts to the all-but-hopeless task of making an actress out of Mabel. Hour after hour he worked with her, pleading, cajoling, threatening, trying to explain the rudiments of acting.

He selected the scene immediately preceding the flood in the Alpine village. Mabel was to be seen kneeling, grief-stricken, at the grave of her parents on the mountain slope when the floods descended.

But the best grief Mabel seemed capable of registering was a blank stare.

"MISS ROGERS!" Don would cry in exasperation. "Try to remember you're not Buster Keaton—and stop staring into that lens. Give us rage, despair, anguish, hilarity, anything at all that looks human!"

"Why Mr. Kennedy!" Mabel would be mildly reproachful. "I've been registering grief for hours!"

Three days of this, and the nerves of both were worn to the breaking point. Mabel drooped visibly. Unconsciously, her face assumed a look which, if it was not quite sorrow, was closely akin to real suffering. At last the ordeal became more than she could bear. At an unusually harsh command from Don, she suddenly burst into tears, and sank down on a large rock beside the mound of the property grave.

Tim, the camera man, knew his business. Quickly he seized the opportunity, and ground away steadily.

"Boy, we've got some swell footage!" he whispered to Don later, as he lifted the cartridge from the camera to hurry it to the developing room.

* * *

Don's party of ten arrived at the Montana ranch near nightfall in a blinding snowstorm, and were heartily welcomed by the Neelys and a score of ranch hands, curious and interested. After a hearty supper, as they were thawing out luxuriously before a *(Continued on page 148)*

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The Movie Maker

(Continued from page 147)

roaring fire in the rough-beamed living room, Don stretched out his long legs and drew a deep breath of satisfaction.

"'"Twas wassail all in the great hall,'" he quoted. "This place—all about here—" he waved his hand vaguely toward the windows, beyond which snowflakes drifted steadily down—"gets me into the mood of the scenes we're going to shoot. Now if a hale and hearty serving man would only come in bearing bumpers of ale, I'd imagine myself back in twelfth-century Merrie England."

A shout went up from the group, for at that moment the Chinese cook shuffled in balancing a large tray of glasses filled with amber liquid.

"How is cider for a substitute?" asked their host jovially, presenting the first glass to Don.

WHETHER it was the cider, the bracing air of Montana, or the long trip, Don slept soundly until noon next day. In the afternoon he supervised the building of a large platform needed for the scene, which was to be the pursuit, in the ice sledges, of the hero and heroine by the villain over a frozen lake in England, the climax occurring in a thrilling crash through the ice.

The Neelys were eagerly interested in the proceedings and the ranch hands so numerous and so anxious to help that Don had to divide them into squads to keep them from getting in one another's way.

When the platform was well started, he left the ranch foreman in charge of the work and with the men of his party took another squad of ranchers on horseback to the lake, about a mile from the ranch house. They dragged the medieval sledges after them and several ranchers offered to test the strength of the ice. After hitching two horses to each of the sledges, they drove across the lake at first carefully, then began to race over the firm, snow-covered ice, while Don and the camera men measured distances and focused for the most advantageous angles.

Finally Don selected a spot about fifty yards from the shore and marked out a rough rectangle in the snow twice the width and three times the length of the sledge and horses—approximately the dimensions of the platform being built at the ranch house. That was all that could be done for the day, as it was growing dark; but next morning, with picks and axes, the ranchers set to work to chop out the rectangle, piling the blocks of ice on a sledge to take back to the ranch ice house.

SPEED was necessary, and the men worked valiantly, the motion picture men taking their turn with the rest. At three o'clock, when the hole was nearly completed, the group from the house dragged down the huge platform in sections. They relieved the ice workers and an hour later, as dusk was beginning to make work difficult, the platform, joined solidly together, was lowered into the hole and wedged below and between the surrounding margin of ice. The water gurgled up over it, hiding the platform more than three feet beneath its surface.

It did not snow that night, and when Don went to the lake early the following morning he found a layer of ice perhaps three inches thick formed over the hole. Hurrying back to the house, he sent several men with brooms to brush snow from the sides over the newly formed ice layer so that it would appear like the rest of the scene.

Shortly before noon the entire population of the ranch traveled down to the lake, six of them bundled up in medieval costumes, as were Judy, Jerry and Margaret. The rest were loaded down with blankets, thermos bottles of hot coffee, ropes, axes, and a first-aid kit as emergency measures. The Neelys' three sleighs were *(Continued on page 149)*

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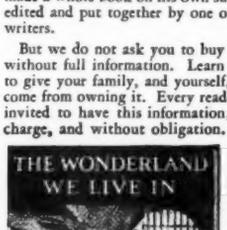

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The Movie Maker

(Continued from page 148)

pressed into service for some, while others traveled on horseback.

Don and the camera men had preceded them, and when the cavalcade came into view, Don shouted through his megaphone:

"Sun's almost right now. No time to lose. Take your places at the far end."

He had given them simple instructions the day before, staging an impromptu rehearsal on the lake; so now the horses, two to each sledge, were quickly bridled with ornamented reins, and the costumed actors and extras piled into the two sledges.

After a few close-ups and foregrounds of the first sledge, with Jerry, Judy and Margaret bearing the major portion of the action, a ranch hand resembling Jerry in stature and wearing a false mustache that duplicated his was substituted for him in the first sledge just after it had started away. The camera, of course, was stopped and started again to allow the substitution. Then Jerry, with a different outer wrap and headgear, drove up in the second sledge, taking the part of his villainous half-brother, and the race was on. A halt was called, however, before the sledges had gone more than a few yards, as the cameras were too close to get a wide range of action.

THE cameras were then moved back to the shore of the lake for the long shots. Both were equipped with a revolving mechanism which would enable them to follow the panoramic sweep of the action.

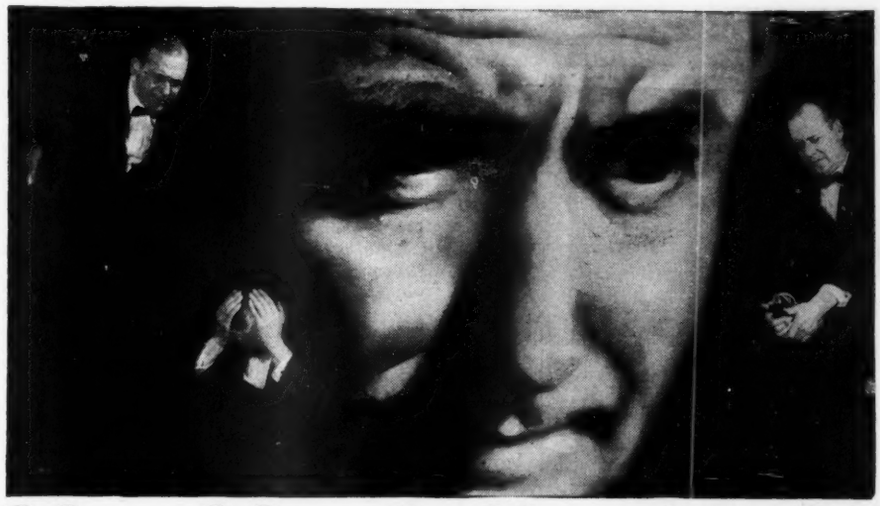
The race was taken up where it had left off, with Jerry again in the front sledge. A few feet before he reached the thin layer of ice he turned his horses sharply, and the cameras were stopped. The crash was to be shot almost as a close-up, and for this Tim placed his camera within twenty feet of the broadside of the hidden platform. The second camera man focused his twenty feet from the far end of the rectangle to shoot the scene as the sledge came head-on to the crash.

When all was ready, Jerry waved his whip and, shouting, urged his horses on. Margaret and Judy, though they shivered in anticipation of the cold plunge before them, registered violent alarm, half-rising in their places and looking back at the oncoming villain. A little distance behind the camera, the audience held their breath as the sledges got a good start again near the end of the lake. The horses were racing magnificently as they flew past the camera.

DON bit his tongue with excitement, for the ice held as the speed of the horses carried them halfway across the rectangle. But it crashed suddenly when the full weight of the sledge slid on to the thin layer of ice. Horses and riders plunged and floundered wildly as the sledge sank into the black water, while the horses pulling the pursuing sledge reared and caused a thrilling spill, tumbling the riders out on the snow.

This was Jerry's big moment in the picture and he was equal to it. With an agility and strength he did not know he possessed, he had the two girls out of the water almost before the sledge sank to the submerged platform. Then, leaping back in again, he slashed the reins and freed the struggling horses. While he was doing this, the two girls fled out of the camera range, pursued by the villain, whose face was turned away from the camera. A moment later he was followed by Jerry. Meanwhile, the other occupants of the sledge had scrambled out as best they could and the last of them disappeared from the camera range as the horses plunged and reared to get on to the heavier ice.

The cameras caught it all. Before they had ceased grinding, two of the Neelys' sleighs had hastened away from the (Continued on page 150)



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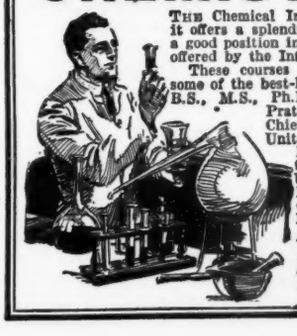

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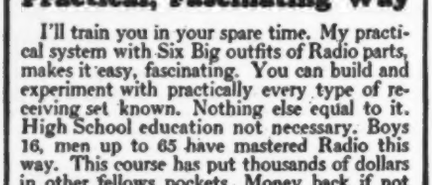

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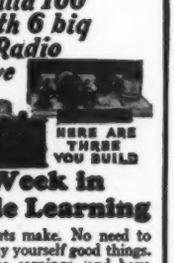

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The Movie Maker

(*Continued from page 149*)

scene bearing those who a moment before had been struggling in the water. Ten minutes later they were all wrapped in warm blankets before the three big fireplaces in the ranch house, their experience leaving only the vigorous tingle of an icy shower bath.

Don remained at the lake, however, till the sunken sledge had been pulled up with grappling hooks. It was too cold and difficult a job to raise the platform, so that was left to wait for the spring thaw.

Though he had asked the professor to telegraph immediately upon news from Bozo, Don had received no message while at the ranch. So he sent a telegram from the railway station in the small Montana town a few minutes before their train was due, instructing the professor to get things ready for a trip to the Mohave Desert. Before giving his telegram to the operator, he showed it to the others.

"THERE goes five thousand, at least," he remarked. "Five thousand that Bozo might have saved us."

Puzzled, Jerry glanced up from the telegram. "What on earth is a 'gobo'?" he asked.

"One of those tall, black triple-hinged screens of wood we use to alter the light reflection for studio close-ups."

"But why are you wiring the professor to give them a coating of gold leaf?" inquired Jerry, still mystified.

"We take gold-painted gobos along as secondary reflectors to be used with mirrors, when we don't carry electrical equipment on location," explained Don. "We need them especially in desert scenes, where there is such strong overhead light that we've got to use some complementary lighting from the sides to counteract the heavy downward shadows. On the face, particularly—"

He was interrupted by the train's whistle, and once aboard, he had more important things to discuss. They had the train almost to themselves, and Don settled himself beside Margaret to try again to find out the financial state of her affairs. He had been unsuccessful on the trip up to the ranch and he knew how necessary it was to proceed with tact. Though of a very gentle nature, Margaret's pride was so great that she would tolerate no suggestion of pity.

SEVERAL seats away, Jerry watched them thoughtfully, then he turned to his sister.

"I didn't tell you, Judy—wanted to think it over—but just before we left Hollywood I was offered twenty thousand for the ranch."

Judy had been staring rather soberly out of the window. Now she looked up in surprise.

"Twenty thousand! A good price, isn't it?"

"Nearly four times what I paid for it! They're probably going to start a real estate boom out that way, but I don't believe I could get any more by holding. And I've just decided—if you're willing—to sell at twenty thousand and let Don have it. He can give us whatever share in his invention he thinks fair."

"He has enough money to finish the picture," Judy replied with sudden coldness.

"Maybe." Jerry was not so certain. "But it's Margaret's affairs he's worried about now. He got it out of the professor that she's liable to lose everything she has unless she makes a payment on some note."

"I'm sorry," commented Judy frigidly, "but I don't know that it would hurt Margaret any more to lose her home than for us to lose the ranch."

"Why, sis! What's the matter with you?" exclaimed Jerry. "You know it's only a matter of a few months before Don's ship will come in. I'm even more certain of that since I've learned that Silas Rogers (*Continued on page 151*)

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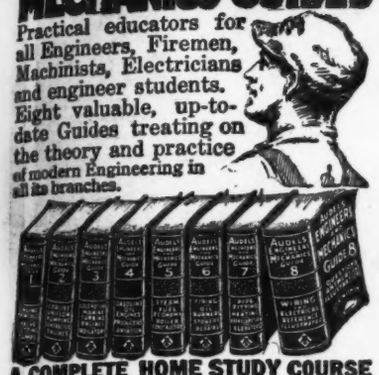

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The Movie Maker

(*Continued from page 150*)

is trying mighty hard to get his hands on Don's background machine."

"Then let Margaret wait! You men always think you have to rush to the aid of a blonde. Just because I'm not all pink and blue and gold I'd have to be on my deathbed before Do—before anybody'd come to my rescue!"

Jerry gave his sister an oblique glance, trying to veil the sudden twinkle in his eyes. But she caught the gleam, and a riotous blush dyed her cheeks.

"You don't appear to be going into a decline right now," drawled her brother. Then he took pity on her. "You must remember that Margaret has risked more for this picture than any of us."

The flush slowly faded from Judy's unhappy face and she looked somberly at the two a few seats away—Don's rugged, honest countenance, intent and admiring, bent somewhat close to the one who was "all pink and blue and gold." At that moment Judy could have slain every blonde between the ages of five and fifty.

"MARGARET may have put more than any of us into the picture," she conceded bitterly, "but it looks as though she's going to get more out of it than any of us. I will not sell the ranch!"

Newsboys entered the train at a station two hours away from Los Angeles.

"Let's see what Silas Rogers' carrion crows are digging up now," remarked Jerry, holding out his hand for a *Star-Clarion*. Then he gasped. Spreading the sheet wide so the four could look on, he read aloud the screaming headlines:

Arab Sheik Asks Huge Ransom for Hollywood Camera Man!

Morocco, Nov. 16. (AP). A million francs and a phonograph is the ransom asked by an Arabian Sheik for Boxworthy Biddle, Hollywood camera man. A message in garbled French and Arabian demanding the ransom was brought into Morocco today from a tiny village near the foot of the Atlas Mountains. The message had evidently been on the way more than a month, for the sheet of paper was torn and dirty and bore the date of October 12. It was addressed to the United States consul at Morocco, who is understood to be investigating the case.

FROM a source of private information, the *Star-Clarion* learns that the "Monsieur Box. Bidle" of the Sheik's note is none other than Boxworthy (Bozo) Biddle, of Hollywood, sent abroad by a unit of Popular Players to shoot scenes in the Arabian Desert. He is now being held for ransom in the rugged mountain stronghold of a minor chieftain, Sheik Ali Radul, who caused the French no little trouble in the recent Riff uprising. The tone of the Sheik's note was that while he might be reasonable about the million francs and shave his price a bit, he would be firm in his demand for the phonograph.

"Now we're in a real jam!" exclaimed Don. "Have to take that desert trip, build the Holy Land sets, and rescue Bozo, all in six weeks! I shouldn't have let him go to Arabia after Carleton's experience there."

"It looks to me," remarked Jerry, gazing meditatively at the bold headlines, "it looks to me as though the sheiks of the desert are getting even with Hollywood at last!"

Things certainly look bad. Can Bozo be rescued from the kidnapers in time to save Don's whole enterprise from ruin? Next month's installment promises some exciting action. It's the best one yet—on the news stands May 2.

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